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CIVIL ENGINEERING.

Experimental Investigation of the Principles of Locomotive Boilers. By Mr. D. K. Clarke, Edinbro'.*

(Proceedings of the Institution of Civil Engineers, London.)

Continued from Volume xxv, page 365.

By the mode of placing the tube plate some distance within the cylindrical part of the boiler, the tubes were not liable to be choked with cinders, or the draft to be obstructed. This plan also afforded an opportunity of reducing the size of the tubes from $1\frac{3}{4}$ inch diameter to $1\frac{3}{8}$ inch, giving, in the same boiler, an equal area of flue passage, whilst, at the same time, the proportion of tube heating surface was increased 34 per cent. per foot of length of tube, and a very large addition of flame surface was gained.

It was further argued that, although the evaporation of water per pound of fuel was the test of the boiler, yet, up to this time, few, if any, experiments could be implicitly relied upon, owing to the quantities being estimated by the measurement instead of by weight, and without due regard to the variation of the temperature of the water in the tender.

As to the evaporative powers of marine boilers, as compared with that of the best locomotive boilers, if an investigation was instituted, it would be found, that the general features of the best tubular marine boilers now used in ocean navigation were nearly identical with those of locomotive boilers, but the circumstances under which they were used were very

* From the London Artizan, May, 1853.

different. In the marine boilers coal was used instead of coke, and the natural draft of the chimney, instead of the urging of the blast-pipe, in a locomotive; salt water was also used, instead of fresh water, and a pressure of about 12 lbs. or 14 lbs., instead of from 60 lbs. to 80 lbs., on the square inch. Although lightness and compactness were important properties in marine boilers, they were less so than in locomotives; and the former were frequently worked for many weeks or months consecutively, without the means of stopping for any extensive repair, or even to be cleaned, except at long intervals. Under these circumstances marine boilers required to be worked less intensely, and the water and flue spaces must, of necessity, be larger, to prevent, their being choked up.

The following statement showed the comparative proportions and effect of the two descriptions of boilers:—

In the Locomotive Boiler.	In the Marine Boiler.
1 square foot of fire grate consumed about 11·2 lbs. of coke per hour.	1 square foot of fire grate consumed about 20 lbs. of coal per hour.
1 square foot of fire grate required about 85 square feet of fire box and tube surface.	1 sqare foot of fire grate, required about 30 square feet of fire place and tube surface.
1 square foot of fire grate with the above surface would evaporate 1008 lbs. of water per hour.	1 square foot of fire grate, with the above surface, would evaporate 170 lbs. of water per hour.
1 square foot of flue surface would evaporate 11·7 lbs. of water per hour.	1 square foot of flue surface would evaporate 5·66 lbs. of water per hour.
1 lb. of coke would evaporate 9 lbs. of water.	1 lb. of coal would evaporate 8·5 lbs. of water.
1 H. P. of 33,000 lbs. lifted 1 foot high per minute, required about 4 lbs. of coke per hour.	1 H. P. of 33,000 lbs. lifted 1 foot high per minute, required about 4·25 lbs. of coal per hour.

From this statement it appeared that, although the proportion between the fire grate and the flue surfaces was widely different, the quantity of water evaporated and the power obtained by the consumption of a given weight of fuel were nearly the same, when allowance was made for the difference in the evaporative power of coal and coke.

After explaining the table of "working results," &c., it was contended that, in no case did the formula accord entirely with the practical results recorded in the table; the nearest approximation being that of the "Rocket."

It had been found, in the altered goods engine, that certain practical inconveniences arose from the horizontal transverse water tubes, and two or three mid-feathers had now been substituted for them.

It had been found that intense combustion was liable to cause the formation of clinkers in the small fire box, but which did not occur in the new engine. When the drivers first took out the new engine, being unaccustomed to its peculiar action, they kept thin fires, and drew too much air through the fuel, which was wasted, by raising steam too freely; latterly, the fires had been kept thicker, and the combustion had been slower, whilst the supply of steam had been fully equal to all demands upon the engine, which, it should be recollected, had been built expressly for conveying heavy loads at high speeds, and whose performances, under these circumstances, were contended to have been among the best recorded results of the present day. To set at rest all questions as to duty performed,

it was proposed to institute a set of experiments, or trials, with certain loads at given speeds; the tests to be "consumption of coke per ton per mile, and time of performance." The results to be communicated to the Institution.

The possible maximum evaporative power of 1 lb. of carbon was deduced from the results of chemical experiments, showing that 1 lb. of carbon, converted into carbonic acid, developed 14,000 units of heat, or would raise 14,000 lbs. of water through 1°, which was equivalent to the conversion of 12 lbs. of water at 60° into steam of 120 lbs.

The formula was shown to be derived directly from the tabulated results; it was a mere embodiment of results, and represented no theory.

It was explained that the formula referred to the economical evaporative power of boilers, and that it was in no way designed to limit the unconditional evaporative power; that a boiler might raise less or more steam than the quantity assigned by the formula, but, in the latter case, only by a partial sacrifice of the fuel.

In the comparative trials of the Crewe engines and the new engine with enlarged fire box, it was shown that, looking simply to the boilers, the Crewe boilers raised a greater total quantity of water per hour, and more water per foot of grate per hour, than the new boiler, with greater economy, in the ratio of $8\frac{1}{4}$ lbs. per pound of coke by the Crewe boiler, to $7\frac{3}{4}$ lbs. by the new boiler.

It was explained, with respect to the greater time lost by the Crewe engines on the trial, that the defect lay not in the boilers, but in the exposed position and unprotected state of the cylinders, by which steam was condensed; and in the too large size of the chimneys, which should have been only 12 inches, instead of 15 inches diameter; and in the blast pipe, which was carried too far into the chimney.

The formula being applied to the new boiler, indicated that it could not economically evaporate above 120 cubic feet of water per hour; and the correctness of this indication was confirmed by the result of eighteen experiments by Mr. Marshall, as they showed that, though 150 feet of water per hour had been evaporated, it was at a sacrifice of one-fourth of the fuel, as only $7\frac{1}{2}$ lbs. were evaporated per pound of coke.

With respect to the rapidity with which the new form of boiler could get up the steam, and which was attributed to the free draft, it was shown that the "Rocket," the first tube-boiler engine ever made, got up steam in less time than the new boiler.

The benefit of the removal of the tube-ends in the new boiler from the direct action of the fire was considered to be more than balanced by the liability of the lower part of the combustion chamber to become overheated, and to be burned away, owing to the lodging of steam at the junction with the fire box.

It was suggested that, in order to obtain better results from the new engine, the combustion chamber should be abolished, the number of the tubes should be reduced, and their length be extended to the firebox, which should be restricted to 16 square feet of area.

It was further argued that, in the statement of "actual working results," &c., the formula had been misunderstood and wrongly applied; for instance, in the two Crewe engines, of identical proportions, the results of

the formula were stated as 86·2, 84·4, and 73·7, whereas the same results ought to have been applied to each. In No. 291 engine a similar discrepancy was apparent, the results being 116·5 and 102·7.

In the experiments themselves there were several unexplained anomalies, and, in some instances, the engines, instead of working at their full power, were performing very inadequate duty, and, therefore, under circumstances to which the formula was not intended to apply.

In the case of the altered goods engine, No. 125, it was urged that, in its original state, the engine must have been either in a very inefficient condition, or that its duty must have been chiefly confined to piloting, when it would have been consuming the fuel without producing any useful effect, as a consumption of 51 lbs. or 58 lbs. per mile run, with an average train of 115 tons, was out of all proportion.

That the result of the working, after alteration, viz., a consumption of 39 lbs. and 43 lbs. per mile run, with a load of 144 tons, was not favorable, as compared with the performance of a narrow-gauge engine reported on by Mr. D. Gooch in the gauge inquiry, where, with a consumption of 47 lbs. per mile, a load of 294 tons was conveyed: also, when compared with the working of the Eastern Counties goods engines for the last half-year, where, with an average load exceeding 170 tons, the consumption of coke was only 32 lbs. per mile, taken over a distance of 529,000 miles.

A comparison was drawn between the recent experiments, by Mr. Marshall, on the large firebox engine, and those on the long-boiler engine, made during the gauge inquiry, the results being, with the former, a consumption of 40 lbs. per mile with an average load of 64 tons, and, with the latter, a consumption of 27 lbs. per mile with a load of nearly 60 tons.

The recorded results of the passenger trains on the Eastern Counties line, for the last half-year, showed an average consumption of coke under 18 lbs. per mile run.

It was contended that, hitherto, no advantages had resulted from the extension of the fire-box and the reduction of the length of the tubes; still it was possible that this innovation might, by directing attention to the subject, lead to important modifications of the structure of locomotive boilers, which should possess compactness, lightness, power of raising sufficient steam with rapidity for performing the required work, strength to resist the chance of explosions, and a form calculated to diminish the disastrous effects of explosions, when they occurred, facility of repair, especially of the fire-box, which was the part most liable to deterioration, being most severely acted on by the fire, and also requiring more support than the tubes, the latter being, at the same time, cheaper and of thinner metal, whilst, by an extension of their length, the diameter of the external shell of the boiler could be diminished; the fire grate should not be larger than would evaporate the required quantity of water in steam within a given time, with the utmost practical economy of fuel, and, if that were accomplished, it was of little importance whether the evaporating heat was communicated through the fire-box, or by the tube surface.

As to the mid-feathers, it was contended they had, hitherto, only served to extend the dimensions of the fire-box, and to increase the difficulties

of maintaining and repairing the boiler; and that, up to the present time, the results of the experiments upon the boiler, with enlarged fire-box and shortened tubes, exhibited rather a retrograde step, than an onward progressive movement.

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*Harbors of Refuge on the Recoil Principle.**

Mr. W. H. Smith, C. E., the inventor of a new plan for harbours of refuge and defence on the recoil principle, lately explained his principle by working models before the Liverpool Polytechnic Society. He commenced by some general observations as to the high estimation in which harbors were held by ancient nations, and described several defensive works of this description in Rome, in Greece, in Egypt, and elsewhere. The harbor of Syracuse, for instance, was ten miles in extent, and would contain 500 ships, while on the breakwaters were erected temples and ambassadors' residences. Tracing the history of harbors up to modern times, and describing the structure of the defences—chiefly of stone, or huge masses of concrete, he stated that no breakwater yet formed had withstood the tempest. In proof of this, he pointed to Plymouth, Cherbourg, Kingstown, and other places. Even the Bishop Rock Lighthouse, made of cast-iron pillars, was carried away very shortly after its erection. He accounted for the Eddystone Lighthouse standing so firmly by the fact that, owing to the peculiar form of the house, the wave was carried up a beautiful parabolic curve, and its whole weight used to destroy itself; the water being frequently thrown right over the top of the lighthouse. The inventor then dwelt upon the fearful loss of life and property which occurred annually on our coasts, in consequence of the deficiency of harbors, and also from the defects of what harbors we had. He estimated this yearly sacrifice at 1800 human lives exclusive of the fisheries, and 3,000,000*l.* sterling in property. He next reviewed the various modes of forming harbors, the time occupied in their construction, and the large and unnecessary expense attendant upon such undertakings. The design of his invention was to obviate the defects of stone harbors, and to form a protection equally efficient to one-twentieth the cost if of iron, and one-fiftieth the cost if of wood. A small harbor on the recoil principle might be formed of a series of independent open frames or gratings of wood or iron, and be of sufficient depth and capacity to shelter a dozen large ships, at a cost of 8000*l.*; whereas, in stone, it would involve an outlay of about 200,000*l.*

The principle of his invention was clearly and beautifully illustrated by the trumpet-mouthed weed of the Cape of Good Hope (laminaria buxinalis), growing to a height of from 30 to 40 feet, and which formed a natural yielding breakwater, behind which the largest class of vessels could ride securely. The framework, Mr. Smith explained, is secured to the bed of the sea on screw-piles, tied across by iron tie-rods, and the breakwater is intended to be 15 feet above high-water mark. Each timber, or if iron is employed, each angle-iron, is placed the right angle outwards, with an intermediate space of the same width on each side, be-

* From the London Civil Engineer and Architect's Journal, May, 1853.

tween which the divided wave finds its way, and the same with the framing in the rear. The braces are of iron, with a casing of timber, and weighted with heavy iron weights; the ground mooring is lewised into the bed of the sea. The weights are sufficient to keep the sections motionless, except in a storm, when rigidity would endanger their safety; the wave then gradually gives impulse to the section, which drifts as the weights are lifted to the extent of a few feet, as even a solid body, like a ship or a cask, would only be driven about 10 feet to leeward by one wave. The moorings, now released, have absorbed and measured the total pressure of the wave, and spring back with their full reactive force to their original vertical position: the back framing of the section, as it recoils, completely disseminates any remaining wave. Each section being separate from the adjoining one, has an entirely independent play before the vermicular section of the sea.

Mr. Smith concluded by pointing out the economy of his invention, the freedom from silting, the facility of removal, and other advantages which it possessed. The plan has already been laid before the Liverpool Dock Trust, the Chamber of Commerce, and many of the principal literary and scientific societies and associate bodies in different parts of the kingdom.

On Color Blindness in Connexion with the Employment of Colored Signals on Railways. By GEORGE WILSON.*

In the number of your Journal for the 29th of January, 1853, Mr. W. H. Tyndall has drawn attention to the important fact, that the *red* and *green* danger signals employed on our railways, when *seen together* in certain circumstances, may be, and on actual trial were, mistaken for *white*—the safety signal.

He also observes, that "it is not improbable that some of the accidents which have occurred in railway traveling have arisen from the colors of the lights shown being indistinctly seen; perhaps from a confusion of rays from two or more lamps. In some cases most contradictory evidence has been given as to the color of the signal shown." Few, probably, will dispute the justice of Mr. Tyndall's conclusion; but there is a source of danger connected with the use of colored signals, by day as well as by night, not referred to by him,—probably of more importance than that which he has indicated, and, at all events, of sufficient importance to demand notice at a period when railway accidents have been unusually frequent.

It has long been known that certain persons cannot distinguish colors from each other; and considerable interest has been felt in this form of depraved vision since Dalton, in whom it occurred, published the particulars of his case. Under the title of Daltonism, *Chromatopseudopsis*, or color blindness, the peculiarity of sight in question has been referred to by different writers. Those who are curious in the matter will find the subject fully discussed in a 'Memoir on Daltonism, or Color Blindness,'

* From the London Athenæum for April, 1853.

by Prof. Wartmann, in Taylor's 'Scientific Memoirs,' Vol. IV. 1846,—to which the English editor has added some valuable notes.

My present object is, to draw attention to three practical relations of color blindness, namely,—

1. That the affection is much more prevalent than is generally imagined.

2. That red and green, the colors used for danger-signals on our railways, are exactly those which are most frequently confounded with each other by the subject of color blindness.

3. That color blindness implies not merely a confusion in distinguishing between two or more colors, but, at least in many cases, an imperfect appreciation or feeble hold of color altogether as a quality of bodies.

24, *Brown Square, Edinburgh, March* 28.

On Railway Accidents from 1840 *to* 1852 *inclusive.* By F. G. P. Neison, Esquire.*

The author adopted a classification of twelve principal causes of accident, six of which were assigned to circumstances over which the respective companies had no direct or certain control, and the other six to causes which fell directly under their control. The deaths from collisions and from trains running off the line, which constituted a large portion of the whole, had diminished 35 per cent. since 1840; while the deaths occasioned by passengers jumping from the trains in motion, as well as from mounting trains in motion, had increased 123 per cent. in the same period. The subjoined table shows the per centage of deaths from causes *under* the control of companies and *beyond* their control respectively.—

Causes.	1840–43. Pr ct. of total.	1844–47. Pr ct. of total.	1848–51. Pr ct. of total.
Beyond control of Companies . .	37·50	48·44	56·84
Under " "	62·50	51·56	43·16

Thus it appeared that among passengers the deaths from accidents due to causes "beyond" the control of companies had *increased* no less than 50 per cent. during the last twelve years,—while, on the contrary, deaths from causes "under" the control of companies had *decreased* 30 per cent.; these results, taken with the fact that the number killed from all causes had decreased from 1 in a million in 1840 to 1 in 2½ millions in 1851, proved that means and influences were actively at work which were increasing the safety of life, and that accidents would become yearly less and less in ratio to the traffic, in spite of the increasing carelessness of passengers, as shown by the large increase of deaths from causes under their control. In respect to injuries, the number had declined from 1 in 220,000 passengers in 1840, to 1 in 336,000 in 1851; and they differed from the deaths inasmuch as that 13½ per cent. only of the accidents which occasioned them were attributed to causes within the control of the passenger. Hence it was argued that the tendency of accidents arising from details of management was to inflict bodily injury rather than occasion

* From the London Athenæum, April, 1853.

death; for while among accidents due to causes within the influence of the passengers themselves, 55 deaths take place for every 100 injuries, 11 deaths only occur to 100 injuries arising from accidents beyond the control of passengers. The author stated that during the years 1844-51 7,044,469,484 miles had been traveled by passengers, and 176 deaths had happened through accidents from all causes,—hence one passenger had been killed for every 40,025,395 miles traveled; supposing, therefore, a person to travel twelve hours per diem at the rate of 20 miles an hour, including the stoppages, for each of the 365 days in the year, he would be killed by an accident in 456 years. In respect to fares, first-class passengers were charged the minimum scale of fares in 1846, but for second and third-class passengers the minimum charges were in 1847. Until these dates the charges had gradually and uniformly decreased, but since then they had fluctuated at a somewhat higher price, and had recently shown a tendency to increase. The average distance traveled by the passengers of each class had become yearly less and less, and in 1852 stood thus:—first class, 26⅜ miles; second class, 15½ miles; third class, 10 miles; parliamentary class, 16 miles; all classes, 15¼ miles. The author illustrated the subject by a variety of elaborate calculations, and gave their results in tables.

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*Midland Railway.—The Bursting of a Locomotive.**

An accident occurred on Friday evening, the 7th, about 2½ miles from Bristol, on the Midland line to Gloucester and Birmingham, of a very unusual kind. One of two engines which were drawing a goods train, on the train coming to a stand still through the greasiness of the rails, suddenly exploded. Happily the two men driving it were off the engine, endeavoring to prevent the train running back by the application of sprays to the wheels of the tender.

An occurrence of this kind, the explosion of a locomotive, is exceedingly rare. We doubt if there have been anything like half-a-dozen explosions since railways commenced. They commonly give way in the tubes, the weakest part, and save the body of the boiler.

It will be remembered that a few weeks ago we gave a caution, and repeated it, of the excessive pressure now used in the boilers. Eight or ten years back 55 or 60 lbs. to the inch, above the atmosphere, were the ordinary pressures of the steam, except where great lap to the valve, and working expansively, were used. Then the pressures rose to 80, and occasionally to 85 lbs. to the inch. Now, however, the men apply, for the purpose of running a little more economically in coke, a pressure as much as 200, and nearly 300 lbs. to the square inch. Such pressures as those are dangerous in the extreme. We must, however, do the Directors the justice to observe that we believe it is generally unknown to them. What the pressure in the Midland locomotive was we do not know, and perhaps it never will be known, but the fact of the explosion should call the attention of all railway Companies immediately to the perilous practice existing. It is enough surely for travelers to have the risk of collisions, breakages, running off the rails, &c., without subjecting them, for the

* From Herapath's Journal, January, 1853.

saving of a little coke, to be blown to atoms. The explosion of the Midland boiler has happily passed off harmlessly, but another may not do so, and if it should not, it will scarcely be so mild an affair as just frightening the passengers with a report and have done.

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*Traffic on Railways in the United Kingdom of Great Britain.**

It appears from a return just issued by the Board of Trade, that 39,249,-605½ passengers were conveyed upon all the railways in the United Kingdom during the half-year ending 30th June, 1852. Of these 4,669,-356 were first-class; 14,357,197, second class; 6,255,740, third class; 14,052,340, parliamentary class; and 14,972, periodical ticket class. The receipts being respectively £1,011,707, £1,288,294, £254,952, £782,513, and £58,556, making the total receipts for passengers £3,-403,824, including £7,800 for excess fares. The receipts for goods, cattle, parcels, mails, &c., amounted to £3,791,726; total receipts from all sources of traffic, £7,195,551.

The total receipts for conveying 37,881,703½ passengers during the corresponding period of 1851, amounted to £3,359,937, and for goods, cattle, parcels, mails, &c., to £3,389,585; total from all sources, £6,-749,522, showing an increase of 1,367,902 in the number of passengers, and of £446,029 in the receipts in favor of the half-year ending June 30, 1852.

Of the £7,195,551 received in the United Kingdom, the sum of £6,-168,313 was received on railways in England and Wales, against £5,825,-242 at the corresponding period of 1851; £718,675 on railways in Scotland, against £663,925; and £308,569 on railways in Ireland, against £260,354 in the corresponding period of 1851. Of the 39,249,605½ passengers conveyed during the half year ending June 30, 1852, 32,-682,415½ were conveyed on railways in England and Wales, against 30,883,566 at the corresponding period of 1851; 3,905,724 on railways in Scotland, against 4,333,135½; and 2,661,466 on railways in Ireland, against 2,665,002 at the corresponding period of 1851, showing an increase of 1,798,849 in the number of passengers conveyed on railways in England and Wales, and a decrease of 427,411 in the number conveyed on railways in Scotland, and of 4,536 in the number on railways in Ireland as compared with the corresponding period of 1851. The aggregate length of railway open for traffic in England and Wales at the end of June, 1852, was 5434 miles against 5200 miles open at the corresponding period of 1851, 962 miles in Scotland against 961; and 680 miles in Ireland, against 537 miles; making the total length of railway open for traffic, 7076 miles against 6698 miles open at the corresponding period of 1851.

* From Herapath's Journal, No. 732.

LAW REPORTS OF PATENT CASES.

For the Journal of the Franklin Institute.

Fire Proof Safe Case.

In the Circuit Court of the United States for the Western District of Pennsylvania. { Crandale Rich & Co., *vs.* Lippincott & Barr.

This was a suit brought by the plaintiffs as assignees of Daniel Fitzgerald, to recover damages for the infringement of letters patent* granted to Fitzgerald, June 1st, 1843, for an improvement in iron safes. It was tried at Pittsburgh before Mr. Justice Grier and a jury, in May last.

Messrs. Seth P. Staples and A. W. Loomis appeared for plaintiffs; Messrs. Shaler, Stanton, and Umbstetter appeared for defendants.

The case was one of much interest, both from the reputed value of the patent right, the damages claimed in this case, and from the previous litigation that had taken place in New York and Boston under the same patent. In a suit tried before Judge Nelson at New York, in the year 1848, a verdict was found sustaining the validity of the patent. In that case, for the first time in this country, the doctrine was announced that if a new machine or art had been previously known, and had been afterwards entirely lost sight of and forgotten, and the memory of the old machine or art had passed away, such a prior knowledge would not invalidate a subsequent patent obtained by one who had discovered anew the same art or machine. This view was adopted by Judge Nelson in his charge to the Jury on the trial of that cause, who thereupon found a verdict in favor of the patent, and the same view was afterwards sanctioned by the Supreme Court of the United States.

Justices McLean, Daniels, and Grier, dissented from the opinion delivered by the Court. The peculiar state of the facts on which that question came before the Jury in New York, and before the Supreme Court, was this:

It appeared that James Conner, who carried on the business of a stereotype founder in the city of New York, made a safe for his own use

* We give below an abstract of the Specification of Fitzgerald's Patent, describing his invention in his own words. The improvement is known as the Salamander Safe.

"I take two iron chests, in the common and ordinary way of making iron safes, which is well known to those engaged in this branch of business; one smaller than the other, which, when the safe is put together, forms the inner chest or inner part of the safe. The other chest is made about three inches larger than the inner one, and so as, when put together, it will form the outer part or crust of the safe, and leave a space between the inner and outer chests of the safe of about three inches; which space may vary a little, more or less, when the chests are put together, but should be the same all around and in every direction. The inner and outer doors, when two doors are used, are prepared in the same way, leaving a space, as above, between the inner and outer crust of each door, which space is left for a like purpose with that left between the inner and outer chest of the safe. Where one door is used, it should be made in the same manner, leaving a space between the inner and outer crust or face of the door, and for a like purpose, and should be fitted to the chest or safe with great accuracy. The edges and openings for the doors are to be neatly finished, as in other chests. I then take plaster of paris or gypsum, and

between the years 1829 and 1832, in which plaster of paris was employed as a non-conductor, for the protection of his papers against fire; and that he continued to use this safe until 1838, when it passed into other hands. It was kept in his counting-room, and known to the persons engaged in the foundry; and after it passed out of his hands, he used others of a different construction.

It did not appear from the evidence in New York, what became of this safe afterwards. And there was nothing in the testimony from which it could have been inferred that its mode of construction was known to the person into whose possession it fell, or that any value was attached to it as a place of security for papers against fire, or that it was ever used for that purpose.

Upon these facts the Court instructed the jury, that "if Conner had not made his discovery public, but had used it simply for his own private purpose, and it had been finally forgotten or abandoned, such a discovery and use would be no obstacle to the taking out of a patent by Fitzgerald, or those claiming under him, if he was an original, though not the first, inventor or discoverer."

In delivering the opinion of the Court, Chief Justice Taney compared Fitzgerald's discovery to the discovery of one of the lost arts. "It is well known," he said, "that centuries ago discoveries were made in certain arts, the fruits of which have come down to us, but the means by which the work was accomplished are at this day unknown. The knowledge has been lost for ages. Yet it would hardly be doubted, if any one now discovered an art thus lost, and it was a useful improvement, that, upon a fair construction of the act of Congress, he would be entitled to a patent. Yet he would not literally be the first and original inventor; but he would be the first to confer on the public the benefit of the invention. He would discover what is unknown, and communicate knowledge which the public had not the means of obtaining without his invention. Upon the same principle and upon the same rule of construction, we think that Fitzgerald must be regarded as the first and original inventor of the safe in question. The case, as to this point, admits that, although Conner's safe had been kept and used for years, yet no test had been applied to it, and its capacity for resisting heat was not known. There was no evidence to show that any particular value was attached to it after it passed from his possession, or that it was ever afterwards used as

having boiled it or baked it in an oven, and calcined it and reduced it to a powder, I mix it with water till it is about the consistency of cream or thin paste, so fluid as that it may readily be poured into the space left as above to receive it; and I then fill all the space with the plaster of paris, putting in some sheets of mica between the inner and outer chest, to aid if necessary in checking the progress of the heat. * * *

"The above composition or preparation of gypsum may be mixed with several other articles, not contrary to its nature, with a view to increase its efficacy in resisting the action of fire; but from my experience, I doubt if they have much effect. * * *

"The chemical properties of this article are such that by the application of intense heat, it imparts a vapor or gas, or some other properties, which effectually stay the progress of the fire, and arrest the influence and effects of the heat. * * * *

"I therefore claim as my discovery and invention and improvement, the application and use of plaster of paris or gypsum, in its raw state, or prepared as above, either alone or with mica, in the construction of all iron chests or safes, in the manner above described, or in any other manner substantially the same."

a place of security for papers; and it appeared that he himself did not attempt to make another like the one he is supposed to have invented, but used a different one. And upon this state of the evidence the Court put it to the jury to say whether this safe had been finally forgotten or abandoned before Fitzgerald's invention, and whether he was the original inventor of the safe for which he obtained the patent; directing them, if they found these two facts, that their verdict must be for the plaintiff. We think there is no error in this instruction. For if the Conner safe had passed away from the memory of Conner himself and of those who had seen it, and the safe itself had disappeared, the knowledge of the improvement was as completely lost as if it had never been discovered. The public could derive no benefit from it until it was discovered by another inventor. And if Fitzgerald made his discovery by his own efforts, without any knowledge of Conner's, he invented an improvement that was then new, and at that time unknown, and it was not the less new and unknown because Conner's safe was recalled to his memory by the success of Fitzgerald's."

This was the principal question presented in the case as tried at New York, and as argued before the Supreme Court. See 10 *Howard*, 477.

In the present case much light was thrown upon that question by the production on both sides, of very full testimony in reference to the nature and extent of Conner's prior use. The relative merits of Fitzgerald and Conner as inventors, were more fully investigated in this case than had been heretofore done, and the precise extent to which the manufacture of Conner had been carried was brought before the Court and Jury. In instructing the Jury as to the principle of law involved in this question, Mr. Justice Grier adopted and cited the decision of the Supreme Court above referred to, and left the application of that principle to the particular facts developed as at this trial, to the Jury.

Several other important questions of fact arose in the course of the trial, and much testimony was introduced. The following, however, were the points of defence chiefly relied on:

First, That the composition used by the defendants was not an infringement of Fitzgerald's patent, because the patent covered only the use of "plaster alone," or "plaster in combination with mica."

Upon this point it was shown that the defendants had for several years been largely engaged in manufacturing and selling iron safes, which were filled in between the linings with a composition of various materials, of which plaster of paris formed only about one-third part.

Second, That Fitzgerald was not the first inventor; but that plaster of paris had been known and used as a non-conductor of heat long before Fitzgerald's discovery; that it had been used in 1832 by James Conner, of New York, in the construction of a fire proof safe.

Third, That Fitzgerald had suffered iron safes filled with plaster on the plan of his patent, to be publicly sold and used more than two years before the date of his application for a patent, and had thereby abandoned his right to a patent.

Upon this point the plaintiffs relied upon the testimony of Fitzgerald and other witnesses, to show that Fitzgerald had directed his attention to plaster of paris, and made experiments as to its non-conducting qualities

as early as 1830; that he made a model and tested its merits in 1832; and having proved it by public exhibition in New York and Boston, applied for a patent in April, 1836, and continued the application, notwithstanding much resistance by the patent office, until it was finally granted in 1843. That before his discovery the qualities of plaster, as a valuable non-conductor for fire proof safes, was unknown; and that from 1836 until 1843, his application for a patent had been continued.

The defendants submitted the records of the patent office and other evidence to show that Fitzgerald's application for a patent in 1836 was for a combination of plaster with isinglass, saltpetre, and potash, which was rejected by the patent office; and that the application for his present patent was not made until 1839, and in the meantime he had engaged in the public manufacture and sale of safes, and suffered others to do so without any objection, ever since 1836.

MR. JUSTICE GRIER CHARGED THE JURY AS FOLLOWS:

Gentlemen of the Jury:—The cases you are sworn to try are two actions between the same parties, brought for an infringement of the same patent. The questions involved in each are the same. They have been consolidated and tried as one action. But in case you assess damages for the plaintiff, you will have to apportion them to each case.

The plaintiffs claim to be the assignees of a patent granted to Daniel Fitzgerald on the 1st of June, 1843. In April, 1839, previous to the issuing of the patent, Daniel Fitzgerald sold and assigned his inchoate right to his discovery or invention, to Enos Wilder. The assignment, though antecedent to the patent, has been decided to be a valid legal assignment of the invention afterwards patented in the name of the inventor.

Enos Wilder afterwards (September 1st, 1843,) assigned all his right and title to Benjamin G. Wilder, and on the 25th of June, 1847, Benjamin G. Wilder assigned the same (with the exception of New York and the New England States) to Crandle Rich, Almon Ruff, and John G. Stephen, the plaintiffs in the case.

The patent purports to be "for an improvement in fire proof chests and safes."

It is important that you note particularly the claim as stated in the specification of what the patentee specially sets forth as his peculiar invention. The law for good reasons requires this to be set forth precisely and specifically, and precludes the patentee from alleging it to be different or more enlarged than he has thus set it forth. It is in these words:

"I therefore claim as my discovery and invention and improvement, the application and use of plaster of paris or gypsum in its raw state or prepared as above, either alone or with mica, in the construction of iron chests or safes in the manner above described or in any other manner substantially the same."

If the plaintiff be the first and original inventor or discoverer of the application and use of plaster of paris to this purpose, and this application produce a new and useful result, it cannot be doubted that it is the proper subject of a patent. It is not for the discovery of the fact or principle that the gypsum has certain qualities not before known, to wit, that it was a non-conductor of heat, but it is for the application of this substance

possessing such qualities, to produce a beneficial result—a manufacture or machine better than any before known.

Assuming for the present, that the patentee is the original inventor of the subject matter of this patent, (for which the patent is prima facie evidence,) and that it is not only a new, but a useful invention, (which is not disputed:)

Your first inquiry will be, has the plaintiff proved to your satisfaction that the defendant has infringed the franchise or monopoly granted by this patent? A question of infringement is one of fact, which it is the province of the jury to decide.

It is impossible for the Court to give you a general or abstract definition of what is an infringement which will be easily applied to every variety of case. "An infringement, is said to take place whenever a party avails himself of the invention of the patentee, without such a variation as will constitute a new discovery." "It may be by making, using, or selling" the thing patented. When the subject matter of the patent is a manufacture, the question will be whether in reality and in substance, the defendant has availed himself of the invention of the patentee; a mere colorable variation in the process or application should not be allowed to protect a defendant.

In order to apply these principles to the present case, you must carefully observe the peculiar nature of the invention, improvement, discovery, or composition of matter claimed in the specification. In the specification the form or proportions of the safe are not claimed, nor the use of one chest within another, nor the idea of interposing a lining of some non-conducting substance between the outer and inner chest to resist the effect of fire. Salt, charcoal, asbestos, soapstone, and perhaps many other substances and compounds have been used for this purpose. If the plaintiff has discovered some substance possessing the requisite qualities for the purpose required, he has a right to patent his invention. But the defendant has an equal right to make or compound any other essentially different composition or substance for the same purpose. But he has no right to avail himself of the plaintiff's invention or discovery by making some colorable alteration in the mode of its application. Now what is the composition of matter which the plaintiff's patent claims to have invented for the purpose of lining chests or safes. It is plaster of paris in the raw state, or calcined or prepared as set forth in the specification, either alone or with mica. Has the defendant used substantially this substance or composition of matter?

Price, the plaintiff's witness, says he furnished the composition used by defendants in making their safes: "*one of his own making;*" that he had used it 25 years, that it contained, not one-third plaster, and many other ingredients.

Now if it be true that the composition of matter sold by witness to defendant was one known and used as a non-conductor for twenty-five years and more, and was not a mere colorable evasion of the plaintiff's patent, taking advantage of his discovery, and merely varying it by a mixture of other ingredients to cover the infringement, even though plaster of paris may have been one of the ingredients of such composition, the use of it is not necessarily an infringement of the plaintiff's patent.

The patentee does not, and could not, claim all compositions known and unknown of which gypsum might be a component part, which might be used as non-conductors in lining safes. He claims gypsum *alone* or with *mica*. If in your opinion the composition used by defendants be substantially the same with that patented, or the defendants have merely varied their composition, to cover the infringement while they obtain the benefit of the plaintiff's discovery, you should find it an infringement. If not, your verdict should be for defendants on this point, and in such case your labors might end here.

2. The next question to be considered (if you find the defendants have infringed the patent,) is whether the patentee is the original and first inventor. As I have said, the patent is prima facie evidence of this, i. e., sufficient till the contrary is shown.

The patent act of 1836, sec. 6, provides, "that any person or persons having discovered or invented any new or useful art or machine, manufacture or composition of matter, or any new or useful improvement on any art, machine, manufacture or composition of matter *not known or used before his or their discovery or invention thereof*," may apply for a patent, &c. The applicant is required "to make oath or affirmation that he does verily *believe that he is the original and first inventor*, &c., and that he does not know or believe *that the same was ever before known or used*." The Commissioner is required before he is allowed to grant a patent "to inquire whether the same had been invented or discovered by any other person in this country prior to the alleged invention or discovery thereof by the applicant," &c.

The mere speculation of a philosopher or mechanic, never put into actual practice or operation, will not deprive a subsequent inventor, who has employed his labor and talents in putting it into practice, of the reward due to his ingenuity and enterprise. But, if the first inventor reduced his theory to practice and put his machine or other invention into use, the law never would intend that the greater or less use in which it might be, or the more or less widely the knowledge of its existence might circulate, should constitute the criterion by which to decide upon the validity of any subsequent patent for the invention. A patent may, therefore, be defeated by showing that the thing secured by the patent, had been discovered and put into actual use prior to the discovery of the patentee, however limited the use or knowledge of the prior discovery might have been. (*Bedford vs. Hunt* 1, *Mason* 302.)

If the original inventor of a machine abandons the use of it and does not take out a patent first, no other person can entitle himself to a patent for it. (*Evans* vs. *Eaton* 1, Peters 323). There are exceptions to this general rule, as in case of a lost art, where the knowledge of it has been lost for ages—and in the present case if you should find that Conner discovered this valuable property of plaster of paris before Fitzgerald had put it in practice by lining the interstices of a safe—but that the safe itself had disappeared, and the knowledge of the improvement was completely lost as if it had never been discovered; and Fitzgerald had afterwards made the same invention and discovery anew, his patent might stand. But, if Conner's safe was in existence and in use, and the knowledge of it not entirely forgotten and lost—his omission to bring it into

public use or notice by public exhibitions or experiments would not give Fitzgerald, if he was a posterior inventor, a right to a patent. Conner might have abandoned its use and been ignorant of the extent of its value, yet if his invention was substantially the same with that of Fitzgerald, the latter would not upon that ground be entitled to a patent, provided Conner's safe and its mode of construction were still in the memory of Conner or in the knowledge or use of others before they were recalled by Fitzgerald's patent. (10 *Howard* 498.)

The evidence bearing on this point has been very fully and ably commented on by the counsel. It is for you to apply it to the principles of law announced by the court.

3. If you should find from the evidence that Fitzgerald was the first inventor of the subject matter of the patent—you will then have to consider a third point made by defendants' counsel: viz., Whether Fitzgerald had abandoned his invention to the public before his application for a patent.

A first inventor cannot acquire a good title to a patent if he suffer the thing invented to go into public use or to be publicly sold for use more than two years before he made application for a patent. "By a public use, is meant a use in public, that is to say, if the inventor himself makes and sells the thing to be used by others, or if it is made by one other person only with his knowledge and without objection, before his application for a patent, *a fortiori* if he suffers it to get into general use, it will have been in public use." *Curtis on Patents*, Sec. 279.

This patent issued in 1843; the immediate application on which it was granted was made in 1839; salamander safes had been made and sold from 1835 to 1839, by Fizgerald and others. The affidavit of Fitzgerald filed with the application of 1839 states that he made this invention in 1835. It is contended by plaintiffs that an application was made before the burning of the Patent Office in 1836 and renewed in 1837. Defendants deny that this application was for the invention patented in 1843; but was for an entirely different one, being a composition of salt, saltpetre, plaster, &c., and moreover that this application was abandoned and the money paid returned, and that after Wilder had purchased this claim in 1839; the first application for the invention as now patented was made by Wilder, who in resuscitating the abandoned claim endeavored to connect it with the former abandoned application for a different invention, in order to save it and give validity to his patent. Which of these hypotheses is true, is for you to decide; the testimony, letters, and documents by which the theory of either party is supported are before you.

If you find that the application of 1836 renewed in 1837 was for this same subject matter now patented—and if such application was not withdrawn by Fitzgerald, but the delay was caused by the conduct of the commissioner of patents in refusing to grant the patent for the same invention since patented, then Fitzgerald should not be considered to have abandoned his invention to the public unless he had abandoned it before 1836, which is not contended.

On the contrary, if you believe that the application of 1836 and 1837 was not for the same with that patented, and therefore was refused by the Commissioner, or was withdrawn and abandoned by the applicant,

and continued so until Enos Wilder got up an application for the present patent, and in the meanwhile the invention had gone into public use for more than two years, then you will find this point for the defendants, and they will be entitled to your verdict.

The verdict was found for the defendants.

AMERICAN PATENTS.

List of American Patents which issued from May 17th, to June 7th, 1853, *(inclusive,) with Exemplifications by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

MAY 17, 1853.

29. For an *Improvement in Pendulum Levels;* Thomas A. Chandler, Rockford, Ill.

Claim.—"What I claim as my invention is, the method of supporting the angular journals of the axle of a pendulum indicator, in turning and self-adjusting bearings of similar form to the angular journals, substantially as herein set forth."

30. For an *Improvement in Violins;* Moses Coburn, Savannah, Georgia.

"The nature of this invention consists in making the apertures, or means of communication between the exterior and interior, in the sides, instead of the top; this is to prevent the weakening of the centre of the top, and the consequent impediment to its perfect vibration."

Claim.—"What I claim as my invention is, the apertures in the sides, instead of in the top, substantially as shown and described, for producing the effect set forth in this specification."

31. For an *Improvement in Vertical Pianos;* Edwin Fobes, Boston, Massachusetts.

"My improvement is practically and usefully applicable to the piccolo alone; as were it applied to the long upright, it would cause the position of the straining pins of the strings to be such as to render it impossible for a tuner to obtain access to them while tuning the piano."

Claim.—"What I claim is, the arrangement of the straining pins with their axes vertical, or nearly so, and parallel, or nearly so, to the general plane of the strings, and to stand above the iron frame as set forth; the string of each hitch pin having guide rollers applied to it, substantially as above set forth; my improvement enabling me to obtain sundry important advantages in the construction and tuning of the piccolo piano forte. And I also claim extending the sounding board upwards above the bridge, and in rear of the bridge plate in the treble, and so as to be capable of vibrating in the rear of and above said bridge plate, all substantially as above set forth."

32. For an *Improvement in Umbrellas and Parasols;* Samuel Fox, (near) Sheffield, England; patented in England, April 6, 1852.

Claim.—"Having described my invention, or the manner of performing the same, I would have it understood that I do not claim the bending or corrugating a metallic plate or bar for the purpose of imparting strength thereto; but what I claim is, the improvement in the manufacture of umbrellas and parasols herein described, the same consisting in making them with ribs and stretchers of plate steel bent in the trough-like shape, as specified, in combination with eyes and connexions, applied essentially as described, whereby they are rendered comparatively much lighter than, and still possess all the requisite strength of those made with solid or round rods of metal in the ordinary way, and at the same time the formation of the eyes and connexions is facilitated."

33. For an *Improvement in Sofa Bedsteads;* Lewis L. Gilliland and Joseph R. Wagoner, Dayton, Ohio.

Claim.—"What I claim as new is, the hinged front board, so arranged that by the turning over the seat to convert the apparatus from a sofa into a bed, the front board shall turn down to prevent it from forming a hard ridge under the sacking, which would be

uncomfortable to lie on, and when the seat is turned back again, to reconvert the bed into a sofa, the front board shall be lifted up again by the act of turning the seat back into the proper position, to support the sacking of the seat. Also, the arrangement of the head and foot boards, so that the act of shutting up the bed will depress them, and opening it out will elevate them again, substantially as herein set forth. Also, the arrangement of the turning seat of the sofa, and the sackings of the bed and seat, in such manner that by the turning of the seat to form the bed, the sacking of the latter shall be stretched, substantially as herein set forth."

34. For an *Improvement in Calendar Clocks;* John H. H. Hawes, Ithaca, New York.

Claim.—"What I claim is, causing a calendar clock to supply its own changes for the irregularities in the length of the months, and showing on its dials the exact and no fractional parts of a day, week or month, by means of the combination of the wheel D, having thirty-one divisions, both of which run together, and independently of each other, at intervals on the same arbor, and the lifting pieces, E F, for supplying the necessary changes in the length of the months; the whole being operated by the hook piece, J, substantially in the manner herein described. I also claim, in combination, the wheel F, of several parts, working spring-tight with the wheel *q*, and the catch piece, K, so that the two wheels may move together, and independently of each other, for the purpose of allowing the day of the month indicator to run during the time that the change is taking place from the end of a short month to the beginning of the next month, while the day of the week indicator passes from one day to another in regular succession, substantially as described."

35. For an *Improvement in Cooking Stoves;* Matthaus Heim, Cincinnati, Ohio.

Claim.—"What I claim as new is, the open bottomed space or chamber behind the fire, encircled at sides and top by flue, and closed at the ends by shifting or movable doors, as described, constituting an accessible and well ventilated arrangement for roasting purposes."

36. For *Improvements in Machines for Cutting Wooden Screws;* Abner H. Longley, Lebanon, Indiana.

"The nature of my invention consists of an auger arranged to operate inside of the screw cutting apparatus, or a reducing tool, to make a tenon in front of a screw cutting apparatus, so as to bore the hole, or make the tenon, and cut the screw in it or upon it, at one and the same operation, and thereby save 25 per cent. of the labor required to do the same work by the machines heretofore used for that purpose."

Claim.—"What I claim as my invention is, giving an equal progressive motion to the cutting tools, in combination with a differential rotary motion, for the purpose of cutting the screws at the same time the hole is bored, or the tenon is made, in the manner and for the purposes set forth, substantially as described."

37. For an *Improvement in Upholstering Furniture;* Frederick Mathesius, City of New York.

"The nature of my invention consists in attaching to the edges of the brocatelle, hair cloth, or other material to be used for the outside, or fancy covering of a chair or sofa seat, or any other article to be covered, ligaments or springs, made of india rubber, or any other material equally as elastic, that will give or stretch when required."

Claim.—"What I claim as my invention is, the covering the seats or other parts of upholstered furniture, or other articles and things, by means and with the aid of elastic ligaments, or springs attached to the edges of the covering, and to the frame work of the article covered, in such manner that the outer or fancy covering, however much used or pressed down, upon being relieved from such pressure, will resume and retain an even and smooth surface, using for that purpose india rubber or springs, or any other elastic material which will produce the desired effect, substantially as herein set forth and described."

38. For an *Improvement in Seeding Hoes;* Julius A. Pease, City of New York.

Claim.—"What I claim as new is, the combination and arrangement of a double bladed hoe, with seed box and drop, as before described, for the purpose of planting separate kernels of corn at equal distances apart."

39. For an *Improvement in Pocket Combs;* Wm. J. Thorn, Westbrook, Maine.

Claim.—"What I claim as new is, the manufacture of pocket combs with semi-circular

joints, in combination with strips over-lapping them, substantially in the manner and for the purpose as herein set forth."

40. For an *Improvement in Castors for Furniture;* Wm. W. Wade, Springfield, Mass.

Claim.—"What I claim as my invention is, the arrangement of the male screw on the spindle, in combination with or respect to the arrangement of the female screw in the socket of the socket piece, and to the bearing surfaces of the said parts, substantially as specified or represented, whereby the spindle is not only preserved in the socket piece by the two screws, but allowed freely to rotate when its bearing surface is in contact with the bearing surface of the socket, as described."

41. For an *Improvement in Graduated Cutters for Cloth and other Substances;* Halsey D. Walcott, Boston, Massachusetts.

Claim.—"I claim, in connexion with the cutting knife, the improvement of making the bed to move or rotate transversely, in combination with making the surface of it, which acts in conjunction with the knife, of variable length or lengths, in order by moving or turning the bed around under the knife, different lengths of cut may be produced, substantially as set forth. And I also claim the improvement of combining with the knife and tubular cutter, and a rotary shaft or cylinder placed under them, the two triangular or trapezoidal beds or surfaces, arranged on the shaft or cylinder as described, whereby a cut or button hole may be made of any desirable length, either with or without a hole at one end, as stated."

42. For an *Improvement in Cleansing and Cooling Block Dies in Rivet Machines;* Davis L. Weatherhead, Philadelphia, Pennsylvania.

"My invention and improvement relates to the cooling of closed or block dies, in which rivets are headed and shaped, and consist in expelling therefrom the particles of oxide, cinders, &c., that fall from the article being formed, by means of a current of water, steam, air, or other fluid."

Claim.—"What I claim as my invention is, clearing cinders, scales, and other obstructions from a socket die made in a solid block, for the purpose of heading rivets by forcing in at the closed end of the die, a stream of water that washes out the cinders, &c., every time a rivet is discharged; the inner end of the socket of the die being closed, so that the pressure of the head of water is rendered available for forcing obstructions out of the die, as herein set forth."

43. For an *Improvement in Lime Kilns;* Samuel J. Seely, City of New York; antedated November 17, 1852.

Claim.—"What I claim is, the process herein described, of calcining limestone in a kiln, by the aid of furnaces, and an artificial draft of air through the furnaces and the kiln, maintained by a mechanical blower, substantially as herein set forth. I also claim the combination of a suction blower at the top of the kiln, and a forcing blower at the bottom thereof, substantially as herein set forth. I also claim the method of regulating the production of steam to generate the power for the engine, in proportion to the duty required of it, by setting the steam boiler in the same furnace that supplies the heat for calcining the limestone, substantially as described."

44. For an *Improvement in Track Clearers to Harvesters;* Wm. F. Ketchum, Assignor to Rufus L. Howard, Buffalo, New York.

Claim.—"What I claim is, the scraper or raking board, constructed as described, or in any similar manner, and combined with the rack piece at an angle less than a right angle, substantially as in the manner and for the purpose herein fully set forth."

45. For an *Improvement in Corrugated Plates for Steam Boilers, &c.;* Richard Montgomery, Assignor to Elizabeth Montgomery, City of New York; foreign patent dated February 17, 1853.

Claim.—"What I claim is, the corrugated metal plate as herein described, with flat margins of greater thickness than its middle."

46. For *Improvements in Air Engines;* James A. Woodbury, Winchester, Joshua Merril, Boston, and George Patten, Charlestown, Mass.; patented in England, Jan. 5, 1853.

Claim.—"We claim as our invention the mode substantially as specified, of using air as a motive power; said mode consisting in the employment of a receiver, in which air is to be highly compressed, heated, and maintained at or about a uniform pressure, a suitable

working cylinder and piston, with the ordinary appendages, an air pump or pumps, worked by the engine for supplying the receiver, when the same are connected or combined with suitable devices, as set forth, for cutting off and working the air expansively, and according to the degree of compression of the air; all substantially as herein set forth. We also claim in combination with such an engine, the device for regulating the pressure of the air in the receiver, and economizing the power of the engine; said device consisting of the weighted bar, entering the receiver through a stuffing box, and connected at its opposite end with the stop cocks attached to the chambers of the air pumps, substantially as described, intending to use any known means for accomplishing the two-fold purpose of regulating the pressure of air in the receiver, and opening the pump chambers to the atmosphere, so that the pump shall be relieved from unnecessary labor."

47. For an *Improvement in Seed Planters;* Wm. Cressler, Shippensburg, Pennsylvania.

Claim.—"What I claim therein as new is, in combination with the adjustable tubes, the seeding wheel, with its flanch and partition, for adjusting, receiving, and carrying the grain and other material to be sown with it, around to the opening whence it is conveyed to the ground, as herein fully described and represented."

MAY 24.

48. For *Improvements in Machines for Pulverizing Auriferous Quartz, and Amalgamating the Gold;* Hiram Berdan, City of New York.

Claim.—"What I claim is, 1st, attaching the ball or sphere, obliquely, to the inclined shaft, by the pin, box, and sleeve, substantially as described, in combination with the inclined shaft and inclined bowl, as herein set forth. 2d, In connexion with the said bowl, I claim the heating chamber or furnace, arranged, constructed, and operating in the manner and for the purpose herein specified."

49. For an *Improvement in Gas Burners;* Samuel R. Brick, Philadelphia, Pennsylvania.

"The object of my invention is, to make the flow of gas, at the burning point, uniform and not excessive, notwithstanding a variation of pressure in the main gas pipes, on the combined principles operating in the same successive order, and by the combined means herein set forth."

Claim.—"I do not claim passing the gas through a small long aperture; nor a sudden deflection of it; nor a descent of it; nor any of them together, less than the whole. What I do claim is, the arrangement and combination of the centre conducting pipe, and its capping pipe, inside of the common gas burner, in the manner and for the purpose above described."

50. For an *Improvement in an Engraving Machine;* John B. Blair, Alton Illinois.

"The nature of my invention consists in the arrangement of a machine, so as to be capable of performing the work of a graver, or other tool, to produce either mezzotint or other engraving, with a greater uniformity and regularity than that at present done by hand."

Claim.—"What I claim is, first, the so combining of the needle, whether sharp or blunt, with a pentagraph, or other copying or tracing instrument, through the medium of double carriages, moving at right angles to each other, as that the dots or punctures of said needle may be dispersed or aggregated at pleasure, for the purpose of forming the lights or shadows; the character of the lights and shadows being indicated by a sliding scale moving before the eye, or under the hand of the operator, substantially as described. I also claim the combination and arrangement of the sliding box on the bar, the cords, 15, 17, 19, (the first cord connecting the sliding box with the spring lever, and the two latter connecting the sliding box with the pedal,) and the arm 23, for the purpose of moving by means of the pedal the wheel E,' towards or from the centre of wheel F,' on the face of which it works spring tight, to change its motion, and give to the needle a relatively changed motion, substantially as specified. I also claim, in combination with the carriage and needle, the wheel G, with its lifting piece, and the cam wheel, or their equivalents, for changing the character of marks, lines, or dots, upon the plate to be engraved, at pleasure; and this I claim, whether the same be operated in connexion with the pentagraph or not, substantially as described."

51. For an *Improvement in Kettle Bails;* Thomas H. Dodge, Nashua, New Hampshire.

Claim.—"What I claim is, the sliding dovetail or other shaped piece which slides on the bail, in combination with the female dovetail, or other shaped groove cast in the flanch or ear, either on the inside or outside, for keeping the bail permanently fixed in any

position desired, and for any length of time; and, at the same time, admitting of its being left loose, and operating, if desired, like the ordinary swinging bail."

52. For an *Improvement in Radiators for Stoves;* John C. Fletcher, Burlington, Iowa.

Claim.—"What I claim is, the interposition, between the fire chamber and the exit pipe of a stove, of a series of concentric flues, or a spiral flue, so arranged as that the heat of one flue shall pass through the partitions, and in whole or in part be transmitted to the next flue, or portion of the flue, in advance, and prepare it for transmitting the draft through the series, substantially as described."

53. For an *Improvement in Water Metres;* John Hartin, City of New York.

Claim.—"Having described my improved fluid metre, what I claim as my invention is, the adjustable box or stop, in one end of the cylinder, for the piston to strike against, for the purpose of preventing the pin in the arm from straining upon the stop in the slotted arm after the tilting of the lever, substantially as herein set forth."

54. For an *Improvement in the Construction of Harrows;* Lewis Lupton, Winchester, Virginia.

Claim.—"What I claim is, firstly, the constructing the frame of a harrow of double metallic bars, or of flat straps or pieces of metal, and the forming of sockets thereon, by bending the metal, or otherwise, for inserting the teeth or tines, in the manner described, and the uniting the bars or pieces of metal, and the combining therewith, the manner of bracing or staying the same, by the rod and couplings, specifically as set forth. I do not claim the inventing metallic harrows, nor the form thereof; but simply, the improved method of construction, as specified."

55. For an *Improvement in Meat Cutters;* Stanislas Millet, City of New York.

Claim.—"What I claim is, the combination of a set of revolving knives, or cutters, with the top plate and revolving dish, formed as described, and arranged and operating so as to effect the sub-division of the matter, by the action of the cutters upon it, in passing through the slots in the cover, substantially in the manner set forth."

56. For an *Improvement in Watches and Chronometers;* Thomas Nelson, Troy, N. Y.

Claim.—"What I claim is, the method of constructing watches or chronometers, of any kind, so as to permit the employment of a spring barrel, of a size that shall occupy nearly the entire interior diameter of the watch case or frame, and which I effect by placing the movements upon the top of the barrel, and communicating the motion of the barrel to them, by means of a ring, fixed on the interior of the case or frame, with teeth on its inner edge concentric with the barrel, into which teeth the teeth of one or more wheels of the movements may cog or take, substantially as set forth."

57. For an *Improvement in Clover Harvesters;* Jeptha A. Wagener, Pultney, N. Y.

Claim.—"What I claim in the machine for harvesting clover heads without the stalks is, the arrangement of the solid or hollow cylinder, set with knives on its periphery, as described, and just near enough to the fixed knife, or to the concave of the fingers, to admit space enough to allow the clover heads to pass through without being crushed, and so that the combined action of the forward movement of the machine, and the adjustable guard plate, and the knives, the stems may be drawn in and severed close to the heads. 2d, Making the teeth so that they will spring and vibrate towards or from each other, substantially as described.

58. For an *Improvement in Spirit Lamps;* Alexander J. Walker, City of New York.

Claim.—"I do not claim the employment of the inner wick tubes, secured in a stationary bar, and having other tubes sliding over them, which extinguish the light, when the top of the lamp is unscrewed; but what I do claim is, the employment of the plate which serves as a protection against the fluid rising too high, and becoming heated, and exploding; and also as a support for the inner tubes; in combination with the spiral spring and rod, the rod serving to connect the said plate with the top of the lamp, and the spring serving to hold the plate firmly down on the flanch, and also to throw up the cap and extinguishing tubes, instantaneously, after the top has been unscrewed; the whole being constructed, arranged, and operating in the manner described."

59. For an *Improvement in Processes of Distilling Rosin Oil;* Madison Page, Williamsburg, New York, Assignor to Samuel W. Hawes, Chelsea, Massachusetts.

Claim.—"What I claim is, the employment, in the manner and for the purpose de-

scribed, in the manufacture of rosin oils of different qualities, re-distilling the same, and purifying it, substantially as herein set forth, the introduction of the steam into the commencement of the goose neck, above the rosin in the still, so that the vaporized oils from the rosin will pass through and be commingled with said steam, in their passage to the worm for condensation, for the purpose of purification, &c., as set forth."

MAY 31.

60. For an *Improved Door Fastener;* Duncan E. McDougall, Troy, New York.

Claim.—"What I claim as my invention is, combining the two levers, or their equivalents, with the retaining lip plate, claw plate, and set screw, or their equivalents, the said screw serving to operate the levers, and force the plate horizontally against and under the door, and retaining it firmly in that position by means of the same and said levers, in the manner and for the purpose described."

61. For an *Improvement in Cultivators;* Philip H. Keck, Morgantown, Virginia.

Claim.—"What I claim as my invention is, the combination of the balancing pivot with a cultivator, constructed as herein described, for facilitating the turning of the same, as herein specified."

62. For an *Improvement in Compound Rails;* Richard H. Middleton, Alexandria, Va.

Claim.—"What I claim as new is, the combination of the continuous case rail with the split rail, the halves or parts of the latter being constructed with shoulders, that rest on the sides of the case rail, while their lower edges fit into and rest upon the bottom of the same; and the whole being arranged substantially as shown and described."

63. For an *Improvement in Fire Places and Stoves;* Chas. Neer, Troy, New York.

Claim—"Having described the nature of my invention, what I claim therein as new is, the combining with the fire box of a fire place, heating stove or furnace, an inverted pyramidal shaped air chamber, open at top, and suspended over the fire, so that the inclined sides thereof shall radiate the heat and throw it against the fire box plates on all sides; and this I claim, when the fire box is flanked or surrounded by a series of one, two, or more air heating and smoke and gas flues, for the purpose of exposing all the heated plates to the current of air to be warmed and drifted into the room or apartment to be heated, substantially in the manner and for the purpose herein described."

64. For an *Improvement in Bank Locks;* Thomas P. Murphy, City of New York.

Claim.—"What I claim is, 1st, The slides and pins operated in the manner described. 2d, The pressure plate, pressure bolt, and spring attached to the plate, arranged and operating as described, or in any other way substantially the same, for the purpose set forth."

65. For an *Improvement in Grate Bars;* Marie Louise Roucout, Paris, France; patented in France, September 10, 1851.

"The invention consists in constructing the bars of furnaces and other grates, of an arched or partly arched form, with a double row of parallel air holes made in the length of the bars, which, combined with the arrangements described, prevent the clogging of combustible to the bars, greatly improves the combustion, and produces an important economy of fuel."

Claim.—"Having described the nature of my said invention, and the manner of carrying the same into execution, what I claim as my invention is, the construction of bars of furnaces and other grates, of an arched or partly an arched form, provided with two parallel rows of air-holes, substantially as described."

66. For an *Improved Gold Washer and Amalgamator;* Arnold Buffum, Assignor to J. D. Lynde, City of New York.

Claim.—"What I claim as my invention is, 1st, The furnishing of the centripetal discharging compartment, with a horizontally revolving, water moving, and ore guiding table, in combination with a discharging aperture, surrounded by a conical inclined plane at the centre. 2d, The arrangement of the circular guiding channels with connecting openings, so adjusted as to secure an irregular spiral passage from the periphery to the aperture at the centre. I claim these arrangements for gold separators, whether the centrifugal and centripetal compartments be used in combination, or either of them separately."

67. For an *Improvement in Compositions for a Filter;* Wm. H. Jennison, Assignor to Charles Millington, (now deceased,) and John Jordan, and said Millington's Executrix and Executor, and said Jordan, Assignors to James M. Parker, City of N. York.

Claim.—"What I claim is, the combination of animal charcoal, glass, and starch, or its equivalent, treated in the manner set forth, for a filtering composition, as specified."

RE-ISSUE FOR MAY, 1853.

1. For an *Improvement in Reaping Machines;* Cyrus H. M'Cormick, Chicago, Illinois; patented October 23, 1847; re-issued May 24, 1853.

Claim.—"What I claim as my invention, as improvements on the reaping machine, secured to me by letters patent bearing date the 21st of June, 1834, and the 31st of January, 1845, is, placing the gearing and crank forward of the driving wheel, for protection from dirt, &c., and thus carrying the driving wheel further back than heretofore, and sufficiently so to balance the rear part of the frame and the rake thereon, when this position of the parts is combined with the sickle back of the axis of motion of the driving wheel, by means of the vibrating lever, substantially as herein described. And I also claim the combination of the reel, for gathering the grain to the cutting apparatus and depositing it on the platform, with the seat or position for the raker, arranged and located as described, or the equivalent thereof, to enable the raker to take the grain from the platform, and deliver and lay it on the ground at the side of the machine, as described."

DESIGNS FOR MAY, 1853.

1. For a *Grate Frame;* James L. Jackson, City of New York, May 3.

Claim.—"What I claim is, the combination and arrangement of the figures and ornaments herein represented."

2. For a *Grate Frame;* James L. Jackson, City of New York, May 3.

Claim.—"What I claim is, the combination and arrangement of the figures, flowers, and ornaments herein represented."

3. For a *Grate Frame;* James L. Jackson, Philadelphia, Pennsylvania, May 3.

Claim.—"What I claim is, the combination and arrangement of the figures, flowers, and ornaments herein represented."

4. For a *Grate Frame and Summer Piece;* James L. Jackson, City of N. York, May 3.

Claim.—"What I claim is, the combination and arrangement of the figures, flowers, and ornaments herein represented."

5. For a *Cooking Stove;* Samuel H. Sailor, Assignor to James G. Abbott and Archilus Lawrence, Philadelphia, Pennsylvania, May 10.

Claim.—"What I claim is, the configuration and arrangement of the ornaments in bas-relief, and mouldings on the front plate, side plates, back plate, base plate, oven doors, door and panel, feed doors, draft door, and feet, as fully set forth and described, forming a new and original design for the cook stove, designated as the New World."

6. For a *Cooking Stove;* Julius Holzer, Assignor to James G. Abbot and Archilus Lawrence, Spring Garden, Pennsylvania, May 10.

Claim.—"What I claim is, the configuration and arrangement of the ornaments in bas-relief, and mouldings on the doors, plates, and feet, as fully set forth and described, forming the ornamental design of the cook stove, designated as the Enchantress."

7. For a *Cooking Stove;* Edward F. Robinson, Boston, Massachusetts, May 10.

Claim.—"What is claimed is, the ornamental configuration or design, as exhibited in the drawings."

8. For a *Parlor Stove;* Samuel D. Vose, Albany, New York, May 24.

Claim.—"I claim no separate configuration or parts; but what I do claim is, the combination of mouldings and ornaments, as arranged in the parlor stove, the whole forming an ornamental design."

9. For a *Cooking Stove;* Anthony J. Gallagher and John J. Baker, Philadelphia, Pennsylvania, May 31.

Claim.—"What we claim is, the design and configuration of the ornaments for a cooking stove, as described."

JUNE 7.

1. For an *Improvement in Converting Rotary into Reciprocating Motion;* Henry Baker, Catskill, New York.

Claim.—"I do not claim giving a reciprocating motion to an object, by connecting it alternately to opposite sides of a moving endless belt or chain; but what I claim is, the ring, with its sliding pins, attached to the object to which reciprocating motion is to be given, in combination with the stud, or its equivalent, attached to the endless chain or band, substantially as herein set forth; the points or ends of the said pins being caused to project through to the interior of the ring, to catch the stud, or equivalent, and being withdrawn alternately, to allow it to pass, by springs, levers, and stops, substantially as described."

2. For an *Improvement in Washing Machines;* Thomas A. Dugdale, Richmond, Ind.

Claim.—"What I claim is, combining the wash boards, cords, and floats, substantially as above described."

3. For *Improvements in Propellers;* Henry W. Hewet, City of New York.

Claim.—"I wish it to be understood that I do not limit myself to the mode of construction specified, as other modes of construction may be devised, operating on the same principle, and giving the same action to the paddle, by equivalent means. What I claim is, giving to the paddles, in their circuit, a greater longitudinal than vertical motion, imparted by a crank motion, substantially as specified, in combination with the vibratory motion of a beam or beams, derived from the same crank motion, substantially as and for the purpose specified. And I also claim, in the combination above specified, making the beam or beams slide on the fulcrum or fulcra, substantially as specified, by means of which additional element in the combination, I am enabled to impart to the paddle or paddles the back motion in the direction of the propelling action, during more than the lower half of the crank motion, substantially as specified, and for the purpose set forth."

4. For an *Improvement in Compositions for Treating Wool;* William S. Hubbell and Amos Barrett, Kingsville, Ohio.

Claim.—"We do not confine ourselves to the exact quantity of alcohol and oil, but the quantities we have given work very well; we also do not confine ourselves to the use of pure alcohol, but to alcohol or alcoholic liquors—the pure alcohol, however, if it can be obtained, is to be preferred to any of its mixtures for commercial purposes. Having thus explained our invention, we claim the treating of wool with a composition of oil and alcohol, to prepare and fit it for the several manufacturing operations for which oil has been and is now employed."

5. For an *Improved Door Fastener;* Samuel P. Kittle, Buffalo, New York.

Claim.—"What I claim is, the combination of the bar having the edges with the stop or rest having the lips, constructed and arranged as described. I further claim the combination of the cap with the bar, the effect of the cap being to fill up the space between the edge of the door, when closed, and the casing, as described; all for the purposes and constructed in the manner substantially as set forth."

6. For an *Improvement in Boilers for Cooking Stoves;* R. W. Belson, Philadelphia, Pennsylvania.

Claim.—"What I claim is, the employment of a valve, in combination with the escape tube of culinary boilers; such valve being controlled by the cover, or in any equivalent manner, substantially as herein set forth."

7. For *Improvements in Operating and Locking Knob Bolts;* Oliver Ellsworth, Hartford, Connecticut.

Claim.—"I claim, 1st, The preventer attached to the tumbler of the lock, for the purpose of preventing the bolt being forced inward by means of any instrument from without, as herein described. 2d, I claim, in combination with the pin and spring, the oblique sides or angles, cavity or opening, made in the side of the case of the lock, for purposes already set forth, i. e. for the purpose of converting my lock into a latch, or restoring the connexion between the outer knob and spindle, by means of the rod pin coming in contact with the oblique sides when the inside knob is turned, thereby turning the spindle, and causing the rod pin to be moved out, by reason of the friction of said rod pin upon the sides of said

cavity, as herein set forth. 3d, I claim the introduction of a key through a door or knob, for the purpose of turning the spindle of the lock, thereby causing a lock to be converted into a latch (from the outside), as described. 4th, I claim the thumb pin or disconnecting pin, which pin passes through the outside knob and into the spindle, thereby forming a connexion with the rod, for the purpose of converting the latch into a lock at pleasure, from the outside of a door, as herein set forth."

8. For an *Improved Hose Coupling;* Ralph J. Falconer, Washington, D. C.

Claim.—"I am aware that the draw slide is not a new device in itself, and I do not therefore claim the draw slide as a means of making a tight joint, merely; but I claim the employment of the slide coupling, in combination with the collars of hose, in the manner and for the purpose set forth, by which I am enabled, in the case of water hose, to effect the coupling with the utmost facility while the water is flowing through the hose."

9. For an *Improved Arrangement of Quartz Pulverizer and Gold Amalgamator;* P. G. Gardiner, City of New York.

Claim.—"What I claim is, the arrangement of the vibrating pulverizing basin and amalgamating basin attached thereto, with the screen interposed between the two; said basins being connected to the same shaft, and constructed and operating as described."

10. For an *Improvement in Water Closets;* Herman Goldsmith, City of New York.

Claim.—"What I claim is, the annular water chamber at the upper part of the closet, with a valve, so arranged as to open when the pan or basin closes, and allow a requisite quantity of water to pass around the sides of the pan or basin, and between the sides of the pan or basin and the flanch of the orifice, thus hermetically sealing the orifice, and preventing the escape of effluvia; said valve also closing when the pan or basin is opened, and thus preventing the escape of water from the chamber; the valve being constructed of a sphere or ball, working over a circular opening in the bottom of the water chamber, or constructed in any other manner. It being understood that I do not claim the water chamber, independent of its valve, to operate as above stated."

11. For an *Improvement in Painting on Cloth;* Leon Jarosson, Jersey City, N. Jersey.

Claim.—"What I claim is, the painting upon cloth, previously prepared with the mordant herein described, that will combine, chemically, with colors laid on over the other, and blended by means substantially as described; by which I give great richness to the figures, whilst the tint of each is carefully preserved, and developing and fixing, permanently, the colors, by steam, and restoring the cloth to its natural pliable state, by washing out the excess of coloring matter, substantially in the manner described."

12. For a *Self-Adjusting Platform for Ferry Bridges;* Gerard Sickels, Brooklyn, N. Y

Claim.—"What I claim is, applying or attaching to a ferry bridge, or other boat landing, a movable platform, so arranged with any suitable mechanism as to be operated upon by the boat as it approaches the bridge, in such a manner that the boat causes the platform to move inwards and downwards, when the boat is coming into the slip, and the mechanism or weights herein described, or their equivalents, cause the platform to follow the boat outwards and upwards when the boat is leaving the slip."

13. For an *Improvement in Screw Presses for Packing Boxes;* Geo. W. Wight, N. Y.

Claim.—"I do not claim the cross piece, the form of said cross piece not being novel; nor do I claim the vertical portions of the arms or levers with the hooks on their lower ends, these being common and not new; and I do not claim their combination with the cross piece, which I believe to be in common use; but what I do claim is, the bending of the upper portion of the arms or levers from a vertical position, and tending towards each other, until they reach and are joined to a cross piece or yoke, by joints, at any desired point between the centre of said yoke and the vertical portions of the uprights; thereby giving an oblique or inward direction to the hooks, when the yoke is caused to rise by the operation of a vertical screw."

14. For a *Machine for Boring Rock;* Ebenezer Talbot, Windsor, Connecticut.

Claim.—"What I claim is, the method, substantially as herein described, of applying a rollet cutter or cutters for boring or excavating tunnels and other apertures in rocks or other hard substances, by causing the said rollet cutter or cutters, or sets of rollet cutters, to cut segments of circles from the centre, or near the centre, to the periphery of the tunnel or other excavation, with the concavity towards the machine, in combination with a

motion or motions around the centre of said tunnel, to cause the said cutter or cutters to act in succession on the entire surface to be cut away, substantially as described."

15. For an *Improvement in Artificial Stone;* Julius Hornig and Ludwig Suess, Union Hill, New Jersey.

Claim.—"We do not claim the use of salt for forming a glaze upon pottery wares; but what we do claim is, the mode or process of forming artificial stone, as described; that is to say, we claim the employment of silex, alumina, and salt, mixed and treated substantially in the manner set forth, and in the proportions designated, in the manufacture of artificial stone, meaning by salt, the chloride of sodium, or its equivalent, as set forth in the specification."

16. For an *Improvement in Paper Files;* Hamilton L. Smith, Assignor to H. L. Smith, Cleveland, and Levi Buttles and Henry A. Swift, Ravena, Ohio.

Claim.—"I claim the paper file herein described, with prepared adhesive leaves or margins, as a new article of manufacture."

17. For an *Improvement in Pumps;* L. P. and Wm. F. Dodge, Newburg, New York.

Claim.—"What we claim is, the combination of the cylindrical piston, constructed as herein described, with its valves, and the induction and eduction passages, so that the water all entering said cylinder under pressure, alternately at its ends, and being discharged under pressure through the opening or openings at its side, tends to expand the same, substantially in the manner and for the purpose set forth. We also claim the combination of the piston heads, without the cylinder, with thin valves, and the induction and eduction passages, when these valves are united (to insure simultaneous action), as described, the water entering through the piston heads into the space between the same, and being discharged therefrom through a lateral eduction orifice, the whole being arranged substantially as described; thus dispensing with chambers and partitions in the barrel and valves at the eduction port, preventing leakage, and rendering the pump or engine more simple and effective, and less liable to derangement."

MECHANICS, PHYSICS, AND CHEMISTRY.

Translated for the Journal of the Franklin Institute.

Investigation of the Specific Heats of Elastic Fluids. By M. V. Regnault.

I have been employed for more than twelve years in collecting the elements necessary for the solution of the following general problem:

"A certain quantity of heat being given, what is, theoretically, the moving force which can be obtained from it by applying it to the development and dilatation of different elastic fluids, in the various circumstances which can be realized in practice?"

The complete solution of this problem would give the true theory, not only of the steam engines now in use, but also that of engines in which the vapor of water was replaced by other vapors, or even by a permanent elastic fluid, whose elastic force should be augmented by the heat.

At the time I began these researches, the question appeared to me more simple than it does at present. Starting from ideas then admitted in science, it was easy to define clearly the different elements which compose it, and I imagined processes by aid of which I hoped to succeed, in finding in succession their laws, and fixing their numerical data. But, as usually happens in the sciences of observation, as I proceeded in my studies, the circle continually augmented; the questions which at first seemed to me the most simple, became quite complicated, and, perhaps, I should not have had the courage to attack the subject, if at the beginning I had understood all the difficulties.

It has been admitted until lately, that the quantities of heat disengaged or absorbed by the same elastic fluid were equal, when the fluid passed from the same initial to an identical final state, in whichever direction the transition took place; in a word, it was admitted that the quantities of heat depended only on the initial and final conditions of temperature and pressure, and were independent of the intermediate circumstances through which the fluid passed. S. Carnot published in 1834, under the title of "*Reflections on the Motive Power of Fire*," a work which did not at first excite much attention, and in which he admits, as a principle, that the motive force produced in a fire-engine is due to the passage of the heat from the more heated calorific source which emits the heat, to the cooler condenser which finally collects it.

Mr. Chapeyron has developed mathematically the hypothesis of Carnot, and he has shown that the quantities of heat gained or lost by the same gas, then do not depend solely upon its initial and final state, but also upon the intermediate state through which it is made to pass.

The mechanical theory of heat has regained favor within a few years, and it now employs a great number of mathematicians. But the principle of Carnot has undergone an important modification; it has been admitted that heat may be transformed into mechanical work, and that reciprocally mechanical work may be transformed into heat. In the theory of Carnot, the quantity of heat possessed by the elastic fluid at its entrance into the engine is found entirely in the elastic fluid which issues from it, or in the condenser; the work is done merely by the passage of the heat from the boiler into the condenser, while it traverses the engine. In the new theory, this quantity of heat is not entirely preserved in the form of heat; a portion disappears during its passage through the machine, and the work done is in every case proportional to the quantity of heat lost. Thus, in a steam engine with or without condensation, with or without cut-off, the work done by the machine is proportional to the difference between the quantity of heat which the vapor has at its entrance into the machine, and that which it keeps at the moment of its exit or condensation. In this theory, to obtain the maximum mechanical effect from a given quantity of heat, we must make this loss of heat the greatest possible; that is to say, the elastic force which the expanded steam keeps at the moment of its entrance into the condenser, must be as small as possible. But in every case, in the steam engine, the quantity of heat utilized in mechanical work will be but a very small portion of that which we have been obliged to give to the boiler.

In a steam engine in which the steam is expanded, but not condensed, the steam entering under a pressure of 5 atmospheres, and discharged at atmospheric pressure, the quantity of heat which the steam has, when it enters the machine, is, according to my experiments, about 653 units; that which it retains at its discharge, 637. According to the theory of which I am speaking, the quantity of heat utilized in mechanical work is $653 - 637 = 16$ units; that is, only $\frac{1}{40}$th of the quantity of heat given to the boiler. In a condensing engine, receiving its steam at 5 atmospheres, and the condenser keeping, constantly, an elastic force of 55 min. of mercury, the quantity of heat in the entering steam will be 653 units, and that which it has at the moment of its condensation 619. The heat util-

ized will be 34 units, or a little more than $\frac{1}{20}$th of the heat given to the boiler.

A larger portion of the heat may be utilized in mechanical work, either by overheating the steam before its entrance into the machine, or by lowering as much as possible the temperature of the condenser. But this latter means is hard to realize in practice; it would moreover require a considerable increase in the quantity of cold water necessary for effecting the condensation, which wastes power, and the boiler can only be fed by water which is but little heated. We shall attain the same end more easily by expanding the steam to a less degree in the machine, and condensing the steam by the injection of a very volatile liquid, such as chloroform or ether. The heat which the steam has at the moment of this condensation, and of which but a very small part would have been transformed into mechanical work, passes into the more volatile liquid, which it transforms into vapor of high pressure. By passing this vapor into a second machine, where it expands to the elastic force to which the injection water can practically reduce the condenser, a part of the heat is transformed into mechanical work; and a calculation founded on the numerical data of my experiments, shows that this quantity is much greater than could have been obtained by the further expansion of steam in the first machine. In this way can be perfectly explained, the economical result obtained from two connected machines, the one working with water, the other with ether or chloroform, on which experiments have been recently made.

In the air engines, where the motive force is produced by the dilatation which heat produces upon the gas in the machine, or by the increase which it produces in its elastic force, the work done at each stroke of the piston will always be proportional to the difference of the quantities of heat in the air entering and leaving; that is, to the loss of heat by the air in traversing the machine. But as, in the Ericsson system, the heat which the air gives out, is given up to bodies from which the entering air takes it again, and brings it back to the machine, we see that, theoretically, all the heat expended is utilized for mechanical work; whilst in the best steam engine, the heat utilized in mechanical work is not the $\frac{1}{20}$th part of the heat expended. Be it observed here, that I neglect all the extraneous sources of loss, as well as the mechanical or practical obstacles which may present themselves in the application of the principle.

MM. Joule, Thomson, and Rankine, in England, and MM. Mayer and Clausius, in Germany, starting frequently from different points of view, have developed analytically this mechanical theory of heat, and have sought to deduce from it the laws of all the phenomena relative to elastic fluids. For my own part, I have for a long time expressed in my courses of lectures, analogous ideas, to which I had been led by my experimental labors upon elastic fluids. In these researches, I in fact met anomalies which appeared to me inexplicable in the theories before admitted. To give an idea of them, I will cite some of the most simple examples.

First Example.—1st, A mass of gas under a pressure of 10 atmospheres, enclosed in a space the capacity of which is suddenly doubled; the pressure descends to 5 atmospheres.

2d, Two reservoirs of equal capacity are placed in the same calorimeter; the one is filled with a gas under 10 atmospheres, the second has a complete vacuum. The communication between the two reservoirs is suddenly opened; the gas expands into double its volume, and the pressure is also reduced to 5 atmospheres.

Thus in the two experiments the initial and final conditions of the gas are the same; but this identity of conditions is accompanied by very different calorific results; for, whilst in the first case a considerable cooling is observed, in the second the calorimeter shows not the least change of temperature.

Second Example.—1st, A mass of gas traverses, under atmospheric pressure, a worm, in which it is heated to 100° Cent.; then, a calorimeter, whose initial temperature is 0°. It raises the temperature of the calorimeter t°.

2d, The same mass of gas traverses, under the pressure of 10 atmospheres, the worm, in which it is heated to 100°, then the calorimeter at 0° under the same pressure; it raises the temperature of the calorimeter t'°, and experiment shows that t and t' are but slightly different.

3d, The same mass of gas under the pressure of 10 atmospheres, traverses the worm, in which it is heated to 100°; but when it arrives at the orifice of the calorimeter at 0°, or to any point of its course, the gas dilates, and descends to the pressure of the atmosphere; so that it issues from the calorimeter in equilibrium of temperature with it, and in equilibrium of pressure with the surrounding atmosphere. An elevation of temperature t'' is observed in the calorimeter.

According to the theories formerly admitted, the quantity of heat abandoned by the gas in experiment No. 3, ought to be equal to that of No. 2, diminished by the quantity of heat which has been absorbed by the gas during the enormous dilatation which it has undergone. On the contrary, experiment shows a higher value for t'' than for t' and t. I might multiply these citations, but I should anticipate what I have hereafter to say. I reserve the farther elucidation until I shall publish together the experiments which I have made on the compression and dilatation of gases.

However, the examples which I have just cited suffice to show how careful we must be in the conclusions to be drawn from the experiments in which elastic fluids are in motion, undergo changes of elasticity, and perform mechanical work often difficult to appreciate; for the calorific effects produced depend in great part upon the order and manner in which these changes have taken place.

Unhappily, if it is easy to announce vaguely a physical theory, it is very difficult to specify it with precision, so as not only to connect with it all the facts known to science, but also to deduce from it those which have heretofore escaped observation. The theory of luminous undulations, as it was established heretofore by Fresnel, presents the only example heretofore known in physics. The expression in equations, of the problems of heat looked upon in a mechanical point of view, leads, like all analogous problems, to an equation of partial differences of the second order, between several variables which are unknown functions of each other. These functions represent the true elementary physical laws which

must be known in order to have the complete solution of the problem. The integration of the equation introduces arbitrary functions, the nature of which we must seek to discover by comparing the results given by the equation with those which direct experiments give, and with the laws derived from those experiments. Unhappily, in experiments on heat, direct experiments are rarely applicable to simple phenomena; generally, they attack complex questions, which depend on several of these laws at a time, and most frequently it is difficult to assign the part which belongs to each of them. The experimenter must then endeavor to modify the circumstances under which he operates, so as to vary as far as possible in the respective experiments, the parts which belong to each of the elementary phenomena, and to the law which expresses it. He will thus obtain equations of condition which may be of great aid for the discovery of a general theory; for this, whatever it may be, must always satisfy these equations.

This is the manner in which I have directed my researches, and I have always endeavored to define in the most precise way the conditions under which I was working, so that my experiments might be of service, whatever theory might finally prevail.

I published in 1847, the first part of my researches; they compose the second volume of the *Memoirs of the Academy (of Sciences of Paris)*. Since that date I have not ceased to pursue them; but the experiments which they required were so numerous, the numerical calculations so long and troublesome, that it would have been impossible for me to have executed them, if I had been left to my own individual efforts. I have been powerfully seconded by M. Izarn, who had already lent me his assistance for the first part of my work, and by a young Engineer of Mines, M. Descos, whom the Minister of Public Works has kindly appointed my assistant for the last two years, in order to hasten the conclusion of my work. Let me be permitted thus publicly to express my thanks for the indefatigable zeal with which they have seconded me.

The subjects to which my new experiments have been directed are the following:

1st, The relations which exist between the temperatures and the elastic forces of a great number of saturated vapors; from the feeblest pressures up to 12 atmospheres.

2d, The elastic forces of these same vapors, saturated or not, in the gases.

3d, The elastic forces at saturation of the vapors produced by mixed liquids.

4th, The latent heat of these vapors under different pressures, from the feeblest up to those of 8 or 10 atmospheres.

5th, The latent heats of vaporization of the same substances, in gases.

6th, The specific heats of permanent gases and vapors under different pressures.

7th, The quantities of heat absorbed and disengaged by the compression and dilatation of gases, whether this dilatation takes place in a space whose capacity is augmented, or whether it takes place through a capillary opening in a thin wall, or by a long capillary tube.

8th, The quantities of heat absorbed by the gas when it produces,

during its expansion, a motive force which is altogether consumed in the interior of the calorimeter, or is principally utilized elsewhere.

9th, And finally, the densities of saturated vapors under different pressures.

The experiments which have reference to these different questions, with the exception of the last one, are now nearly finished. But as much time will still be required to put them in order, and discuss them with the proper care, I propose to present the general results, successively, to the Academy, while awaiting the time when I can publish them together.

I will present at present my researches on the calorific capacities of elastic fluids.

The Capacities for Heat of Elastic Fluids.

The specific heat of elastic fluids may be defined in two different ways; in the first, the specific heat of an elastic fluid is the quantity of heat which must be given to a gas to raise its temperature from 0° to 1° (Cent.), allowing it to dilate freely, so as to preserve a constant elasticity; in the second, it is the quantity of heat which must be given to it, to raise its temperature from 0° to 1°, forcing it to keep its volume, its elastic force increasing.

The first of these has been called the specific heat of a gas under constant pressure; the second, specific heat of a gas under constant volume. The first definition, only, coincides with that which has been admitted for the capacity for heat of solid and liquid bodies; it is also the only one which has heretofore lent itself to direct experimental demonstration.

A great number of physicists have employed themselves during the last century, in the examination of the specific heats of elastic fluids; Crawford, Lavoisier and Laplace, Dalton, Clement and Desormes, De la Roche and Berard, Haycrafft, Gay-Lussac, Dulong, de la Rive, and Marcet, have successively published researches on this subject. The greater part of these physicists have sought to demonstrate experimentally certain laws to which they had been led by the ideas which they had formed *à priori* as to the constitution of elastic fluids. They have applied themselves less to determine the numerical values of the calorific capacities of the different gases in relation to that of liquid water generally taken as unity, than to look for the simple relations which they supposed must exist among themselves. The conclusions to which they have come are generally very erroneous.

The work of De la Roche and Berard, which was crowned by the Academy in 1813, is still the most complete on this subject, and the one whose results differ the least from the truth. This superiority is caused not only by the extreme care which these skilful experimenters exercised in their experiments, but also by the direct method which they followed; whilst the greater part of the other physicists had recourse to indirect methods, in which the element they sought, exercised frequently but a very feeble influence.

The general conclusions which De la Roche and Berard drew from their labors were as follows:

1. The specific heats of the gases are not the same for all, whether we consider them in reference to volumes or to weights.

2. The capacity for heat of atmospheric air (that of water = 1) is 0·2669; that of the vapor of water 0·8470.

3. The specific heat of equal volumes of atmospheric air increases with the density, but in a less rapid progression. The ratio of the pressures being $\frac{1}{1\cdot3583}$, that of the specific heats is $\frac{1}{1\cdot2396}$.

4. De la Roche and Berard admit, on theoretic considerations, and resting moreover on direct experiments of Gay-Lussac, that the specific heat of the gas increases rapidly with the temperature.

These are the most precise notions on the specific heat of gases which we at present possess, and which are generally admitted by physicists. The limits within which I am obliged to confine myself in the present extract, prevent me from discussing the methods which have been adopted by my predecessors, or to explain those which I have myself followed. I will merely say that I have met, in this kind of researches, great difficulties, not only in the experiments, but also in point of theory; the considerations which I have mentioned at the commencement of this article, will render them easily understood. Thus, although my first experiments are fifteen years old, and although I announced them at that epoch in the Memoirs on the specific heats of solids and liquids, it is only after using the most various methods, and after having forced the elements of their correction in opposite directions, that I now, with confidence, present my results to the Academy.

According to my experiments, the specific heat of air compared with that of water, is

Between	− 30°	and	+ 10° (Cent.)	0·2377
"	+ 10°	"	100°	0·2379
"	100°	"	225°	0·2376

Thus, contrary to the experiments of Gay-Lussac, the specific heat of air does not vary sensibly with the temperature. Experiments made upon some other permanent gases led to a similar conclusion.

In experiments made upon atmospheric air, under pressures varying from 1 to 10 atmospheres, I found no sensible difference between the quantities of heat which the same mass of gas abandons in cooling, through the same number of degrees. Thus, in contradiction to the experiments of De la Roche and Berard, who found a very notable difference for pressures varying only from 1 to 1·3 atmospheres; the specific heat of the same mass of gas is independent of its density. Experiments made upon several other gases led me to analogous conclusions. I nevertheless present this law with some reserve; I cannot yet decide whether the capacity for heat under different pressures is absolutely constant, or whether it undergoes a very slight variation; because my experiments, perhaps, require a slight correction for the state of motion in which the gas was.

The specific heat 0·237 of the air, compared with water, is notably smaller than the number 0·2669, admitted by De la Roche and Berard; it is derived from more than a hundred determinations made under different conditions.

The other elastic fluids whose specific heat I have determined are:

Simple Gases.	Specific Heats. By Weight.	Specific Heats. By Volume.	Densities.
Oxygen,	0·2182	0·2412	1·1056
Azote, (Nitrogen,)	0·2440	0·2370	0·9713
Hydrogen,	3·4046	0·2356	0·0692
Chlorine,	0·1214	0·2962	2·44
Bromine,	0·05518	0·2992	5·39

In casting the eyes over this table, it is immediately remarked that the specific heats of equal volumes of oxygen, azote, and hydrogen, differ very little from each other; so that we would be led to admit that the specific heat of the simple gases is the same, when these gases are taken under the same volume and at the same pressure. But for chlorine and bromine, numbers have been found nearly equal to each other, but much greater than those which were obtained for the other simple gases.

Compound Gases.	Specific Heats. By Weight.	Specific Heats. By Volume.	Densities.
Protoxide of Azote,	0·2238	0·3413	1·5250
Deutoxide "	0·2315	0·2406	1·0390
Oxide of Carbon,	0·2479	0·2399	0·9674
Carbonic Acid,	0·2164	0·3308	1·5290
Sulphuret of Carbon,	0·1575	0·4146	2·6325
Sulphurous Acid,	0·1553	0·3489	2·2470
Chlorhydric "	0·1845	0·2302	1·2474
Sulphydric "	0·2423	0·2886	1·1912
Ammonia (Gas,)	0·5080	0·2994	0·5894
Protocarburet of Hydrogen,	0·5929	0·3277	0·5527
Bicarburet of Hydrogen,	0·3694	0·3572	0·9672
Vapor of Water,	0.4750	0·2950	0·6210
" Alcohol,	0·4513	0·7171	1·5890
" Ether,	0·4810	1·2206	2·5563
" Chlorhydric Ether,	0·2737	0·6117	2·2350
" Bromhydric "	0·1816	0·6777	3·7316
" Sulphydric "	0·4035	1·2568	3·1380
" Cyanhydric "	0·4255	0·8293	1·9021
" Chloroform	0·1568	0·8310	5·30
" Dutch liquid	0·2293	0·7911	3·45
" Acetic ether	0·4008	1·2184	3·04
" Acetone	0·4125	0·8341	2·022
" Benzine	0·3754	1·0114	2·6943
" Essence of turpentine	0·5061	2·3776	4·6978
" Chloride of phosphorus	0·1346	0·6386	4·7445
" " Arsenic	0·1122	0·7013	6·2510
" " Silicium	0·1329	0·7788	5·86
" " Tin	0·0939	0·8639	9·2
" " Titanium	0·1263	0·8634	6·836

The specific heat which I have determined for the vapor of water, by a great number of experiments, is 0·475; it is only about one-half of that found by De la Roche and Berard. It is very remarkable that the specific heat of the vapor of water is very nearly equal to that of ice, or solid water, and only one-half of that of liquid water.—*Comptes Rendus de l'Academie des Sciences de Paris*, 18 *Avril*, 1853, *p.* 676.

On the Composition of the Substances employed by the Chinese in the Decoration of Porcelain. By MM. Ebelmen and Salvetat.*

(Continued from Vol. xxv., page 411.)

2. *On the Rough and Prepared Colors.*

The collections of colors examined by the authors nearly always contain the colors both in the rough state and mechanically prepared and fit for use. This mechanical preparation is sometimes the only difference between the rough and prepared colors; in other cases, during the trituration of the substance, a portion of *yuen-feng* or *sy-chy-mo* is added to it; the former when it is desired to render the color more fusible, the latter to produce a contrary effect.

The rough colors are generally irregular glassy fragments, sometimes transparent, sometimes opake. They have all the same color if the color be simple, but possess a varied coloration if the color can only be produced by the mixture of two or more different colors. The proportions in which *yuen-feng* is added to those colors which require its addition, are very various even for the same color. This must, in fact, be the case in a country where all the primitive colors coming from distant districts cannot be prepared by the same manufacturer, and where the temperature to which the paintings are exposed depends entirely on the will of the decorator.

The following may be said of the Chinese porcelain colors in general. They are very slowly dissolved in cold, but readily in hot acids. The solutions contain oxide of lead, alkali, and the coloring oxide. Silica is separated, which, if muriatic or nitromuriatic acids have been employed, is mixed with chloride of lead. The readiness with which they are dissolved varies according to the nature of the coloring oxide.

Moist air acts slowly upon these colors when reduced to a fine powder: by the action of the atmospheric carbonic acid, carbonate of lead is formed, which is dissolved with effervescence by diluted nitric acid.

1. *Whites.*

The Chinese have several kinds of whites, which are distinguished under the denomination of first, second, and third quality, according to their beauty. The authors have examined the following kinds, contained in the collection at Sévres:—

Po-ly-pé, literally glass-white of first quality.

Chang-pé, white of second quality.

Pou-pé, white of third quality.

The other rough (*seng*) and pulverized (*si*) whites appeared to possess exactly the same properties as the above, and were therefore not analyzed by the authors. They are—

Chang-yan-pé, superior European white.

Sué-pé, snow-white of third quality.

Yan-qué-pé, European moon-white.

The last mentioned, which is a white with a slight greenish tinge, is a

* From the London Chemical Gazette, No. 242.

mixture of one of the preceding whites with one of the transparent greens, which will be hereafter referred to.

Seng-po-ly-pé, or white of the first quality, requiring no addition of *yuen-feng*. — This white consists of fragments of various kinds, some opake, others opaline, and others of a grayish bullate appearance. All give a colorless powder. The opacity arises from arsenic acid. Analysis gave—

Moisture,	0·40
Silica,	37·00
Oxide of lead,	44·39
Arsenic acid,	6·00
Alumina,	0·27
Oxide of iron,	0·28
Lime,	0·75
Magnesia,	traces
Potash,	9·50
Soda,	0·05
Oxide of copper,	traces

Seng-chang-pé, or white of second quality, not requiring *yuen-feng*.— It has the same appearance as the preceding, and gave the same elements, but in different proportions. Analysis gave—

Humidity,	0·50
Silica and oxide of tin,	37·50
Oxide of lead,	50·94
Arsenic acid,	5·00
Alumina,	0·15
Oxide of iron,	0·30
Lime,	0·60
Magnesia,	traces
Potash,	3·43
Soda,	0·34
Oxide of copper,	traces

This composition differs greatly from the preceding. The proportion of alkali is only a third of that in the *po-ly-pé* white. The difference however would probably be less if the color were homogeneous; but the substance consists of various fragments, some of which are opake and appear to be richer in lead; the others grayish, and probably containing no arsenic acid.

Seng-pou-pé, or white of third quality.—For use, 1 lb. of it is mixed with 12 oz. of *yuen-feng*. This also contains the opake and opalescent masses described above as constituting the *po-ly-pé;* but they are here intimately mixed with a grayish sandy substance, which appears to be the powder of the stone *sy-chy-mo*, previously mentioned.

The opake fragments contained arsenic acid and 38 per cent. of silica, which agrees with the quantity contained in the *po-ly-pé* and *chang-pé* whites. The grayish powder, isolated as completely as possible from the opake fragments, was analyzed separately by the same processes as those followed in the treatment of the other whites. The analysis gave—

Humidity,	0·25
Silica,	70·60
Oxide of lead,	23·70
Arsenic acid,	1·50
Alumina,	0·42
Oxide of iron,	0·35
Lime,	0·23
Potash,	4·00
Soda,	traces
Oxide of copper,	traces

The composition of the gray powder explains perfectly the custom described by Father Ly, of adding 12 parts of white lead to 16 parts of the compound which he calls *pou-pé*.

Ya-pé, or ivory white, literally tooth white.—The collection of Chinese colors brought by M. Itier contains a specimen of white completely prepared for painting. The authors have analyzed this white. It contains the same constituents as the preceding, except that the alkali is in part replaced by oxide of lead. The composition of this color, which effervesces a little of nitric acid, is as follows:—

Water and carbonic acid,	0·40
Silica,	36·00
Oxide of lead,	54·00
Arsenic acid,	5·60
Oxide of iron,	0·80
Lime and magnesia,	1·20
Potash and soda,	2.00

Arsenic acid appears therefore to be a most important agent in rendering the Chinese colors opake. It would however be a mistake to suppose that the use and properties of oxide of tin are unknown to these people. The authors think that several of the numerous whites, forming part of the collection formed by Mr. Rutherford Alcock, owe their great opacity to tin. They have found the following composition for the white enamel of a vase of Chinese manufacture:—

Silica,	38.00
Oxide of lead,	51·00
Oxide of copper,	traces
Oxide of tin,	10.41
Potash and loss,	0·59

The collection of colors recently sent from China to the Musée Céramique by Mr. Rutherford Alcock, contains several specimens of the above described whites. One of these, it is said, requires an addition of $8\frac{3}{8}$ oz., another of $4\frac{1}{2}$, and a third of $2\frac{1}{2}$ oz. of *yuen-feng* to $1\frac{1}{3}$ lb. of color. These various additions correspond with the different fusibilities of the primitive color.

To be Continued.

On Iron, and some Improvements in its Manufacture. By Mr. J. D. Morries Stirling.*

The following remarks will but slightly touch on the ores, chemical composition, and general manufacture of iron; these subjects being greatly too important to be treated of in a communication like the present, and

* From the London Artizan, April, 1852.

requiring much more research and time than the writer can at present devote, even did he feel himself qualified to undertake the task.

It is most desirable that these subjects should be thoroughly studied, as we are certainly more ignorant of the nature and qualities of iron, and of the differences produced by slight modifications in the mode of manufacture, by varieties of fuel, ores, fluxes, &c., than we are of the nature of any other article of manufacture; and it is to be regretted that, in a district like this, where iron manufacture is all-important, so little has as yet been done to elucidate the theory and to improve (on scientific and unerring grounds) the general make of iron, which the writer believes is only to be accomplished by our becoming thoroughly acquainted, as well with the chemical constituents of the various ores, fluxes, &c., as with the changes which these undergo in the various processes of calcining, smelting, refining, and puddling. To do this is probably not in the power of those actively engaged in the making of iron, as their other pursuits would materially interfere with the carrying out the necessarily long series of experiments which would be requisite; and, even could such time be devoted to the pursuit, then we should only have, in all probability, the results of trials made in one district.

There is no doubt that many most valuable improvements have been introduced (more especially of late years) by ironmasters and others connected with the iron trade; but these have chiefly had reference to the later stages and finishing processes in iron making, and to the machinery connected with these processes. Of the chemistry of the blast-furnace, of the changes produced by the process of refining, and in puddling, we are still ignorant. Having devoted a good deal of time to this subject, the writer may be allowed to say, that the more he has studied it, and the more he has seen of iron-making, the more convinced he is of our ignorance; and it is to be hoped that some steps will be taken to improve our knowledge, and render the various processes certain and economical.

The improvements in iron manufacture which are touched on in the following remarks are not of the nature of those alluded to above; they are of an inferior class, and should properly be called improvements in iron, or in the manufacture of certain kinds of iron for certain purposes. It will be unnecessary to enter minutely into the various processes for converting the iron ore into cast and malleable iron, or to describe at length the various materials used.

The chief varieties of iron ore which are used in this country are the clay-band, the black-band, and the hematite. From the hematite the purest pig iron and strongest bar iron are said to be made; and from clay-band a stronger malleable iron is generally supposed to be obtained than from the black-band; but the various qualities can be altered by the judicious ironmaster, and malleable iron of as good quality can be produced from black-band as from the hematite or clay-band. The writer does not here allude to improvement of quality by mixing different ores (by which it is well known the bad qualities of some descriptions are entirely removed), but to the skilful treatment of one or more ores of a somewhat similar character.

The first stage in the manufacture of iron is the conversion of the ore

into cast iron, which is accomplished in various ways. In Great Britain, the ore, after being calcined, if necessary, is introduced, with layers of coal or coke and a flux (usually a carbonate of lime), into a large furnace, and a strong blast (either hot or cold) is urged through the previously kindled mass, to accelerate the combustion of the fuel, and the conversion and fusion of the metal, which is usually tapped from the furnace once in the twelve hours, and run into pigs or ingots, which go by the name of "hot or cold blast iron," according to the nature of the blast employed. The subdivisions of both these sorts of iron are the same, viz., Nos. 1, 2, and 3, when for foundry purposes, and forge or white iron, when intended for being converted into malleable iron; these numbers and qualities of iron are supposed to differ from each other in the quantity of carbon contained in each, although this is doubted by many eminent chemists. No. 1, is certainly darker, softer, and more corbonaceous-looking than the other numbers, and forge or white iron appears to contain much less carbon than any iron intended for foundry purposes; but, as we see a similar effect produced on foundry iron by rapid chilling to that produced in forge iron by the supposed abstraction of carbon, it will, perhaps, be more readily admitted that color is not a test (or at least not a certain one) of the quantity of carbon which iron contains.

It may be here remarked, that the Nos. 1, 2 and 3 give *no real idea* of the nature of the iron; they are relatively comparative, and only indicate the *differences between cast iron of the same district and make;* thus, what is called No. 1 in Wales resembles hard No. 2 in Scotland, and corresponds to Staffordshire No. 2 (average); Welsh No. 2 is fully as hard as Staffordshire No. 3, or Scotch No. 4 (a brand), intermediate between No. 3 and forge iron. As a general rule, Nos. 1 and 2 are adapted for small castings, Nos. 2 and 3 *mixed*, for medium castings, and No. 3, or 3 and 4 in Scotland, or 3 in England, for heavy castings; but the mixtures of Welsh and Scotch, or of Staffordshire, Welsh, and Scotch, are found to make stronger and better castings than those made from one sort of iron.

This mode of producing strong castings has been long practised, and is in many places convenient; and the increase of strength is no doubt satisfactory; but there is still a want of uniformity in result, and an occasional difficulty in keeping to the proportions, and even in obtaining the brands specified by the engineer or architect, or chosen by the founder on his own experience.

It seemed to the writer very desirable, therefore, to obtain, if possible, a kind of iron which should be either uniform and constant in its strength, or, at least, *not under a certain standard*, and, after numerous experiments and trials, he attained this object by making certain mixtures of cast and wrought iron, which have been called "toughened cast iron."

Allusion has already been made to the different numbers of cast iron, and to their qualities; and it ought further to be stated, that No. 1 is considered the weakest, and No. 3 the strongest. To render these uniform in strength, and at the same time to equalize *that of cast iron from different districts*, it is only necessary to vary the quantity of wrought iron introduced, by which means all other mixture is avoided, and so much greater strength insured, as to allow a margin for considerable variation

in strength, from an accidental defect, as well as for a diminution in weight, taking the averages of the toughened cast iron and of the best mixtures.

*Transverse strength of bars, 1 inch square, 4 feet 6 inches between supports.**

Cast iron, average breaking weight	436 lbs.
Toughened cast iron, ditto	733 "

*Tensile strength.**

Cast iron, average breaking weight	7·036 tons.
Toughened cast iron, ditto	11·790 "

*Crushing strength.**

Cast iron, average crushing weight	38·582 tons.
Toughened cast iron, ditto	59·522 "

To render the above more intelligible, the proportions are given below, which have been found to bring very soft Scotch (No. 1 hot-blast) and very hard Welsh (No. 2 cold-blast) to nearly the same strength.

Scotch, No. 1, hot-blast, breaking, when unmixed, at . .	430 lbs.
With a mixture of 33 per cent, of wrought iron scrap, broke at .	713 "
The same Scotch iron as the first, with only 20 per cent. of malleable scrap, broke at about	620 "
Showing a deficiency in the quantity of the scrap.	
Welsh, No. 2, cold-blast, breaking when unmixed, at . . .	440 "
With a mixture of 10 per cent. of wrought iron scrap, broke at .	689 "

The results obtained by Mr. Hodgkinson are very favorable, as shown in the following table, where the breaking weights of common cast iron and toughenened cast iron are given, from the report of the commissioners appointed to inquire into the strength of iron.

Table of Comparative Strength of Cast Iron.

Description of Iron Bars, all two inches square.	Transverse Breaking Load in Centre.	Tensile Breaking Strength.	Crushing Strength.
	lbs.	Tons per inch.	Tons per inch.
Toughened cast iron, with 20 per cent. wrought scrap	2174	11·50	54·64
Low Moor, No. 1	1207	5·67	27·00
Blaenavon, No. 2 . . .	1220	7·46	49·11 30·50
Warrington best gun mixture . .	1375	—	—

Comparative trials, on a larger scale, made by Mr. Owen (by command of the Admiralty), give equally satisfactory results. Tensile strength, according to Mr. Owen, 12·50 tons.

Since these experiments and trials were made, the toughened cast iron has been successfully used in the construction of several public works, Windsor bridges, Chelsea Bridge, Yarmouth Bridge, &c., &c.; and it may be mentioned that, by being allowed to reduce the scantling in proportion to the increased strength gained by employing the toughened cast iron, the contractors for the heavy castings of the Manchester viaduct were enabled *profitably to fulfil* their contract, whereas, had they used

* The averages of the transverse and tensile strength are from the experiments of Mr. Hodgkinson, in the government report and elsewhere, and other experimenters; Mr. Hodgkinson is the sole authority for the resistance of crushing force.

common iron, and been confined to the specification, they would have been heavy losers.

For shafting, rolls, pinions, cog wheels, cast iron railway-carriage wheels, cylinders, and other castings where strength and closeness of texture are desirable, the toughened cast iron will be found most useful; also, cast iron, which will not chill in its unmixed state, readily chills with less loss of strength than usual, when mixed in proper proportions with malleable iron.

To insure that the proper proportion of malleable iron is contained in each pig, and also to render the mixture more easily conveyed from place to place, the writer prefers making the mixture at the blast-furnace; and this is done by distributing the proper weight of malleable scrap in the moulds into which the melted iron is to be run. It is thus firmly fixed, and melts more easily and regularly with the cast iron in the cupola or other furnace, the cast and wrought iron heating gradually to the melting point of the former, when the wrought iron is easily acted upon, and fluxed by the cast iron.

The process of converting cast into malleable iron is much more varied than that of converting the ore into cast iron. In some districts a great proportion of the cast iron is refined previous to its conversion; in others little refined iron is used, and in some works cast iron is at once converted into malleable iron; and this latter process seems to be gaining ground.

Refining is, perhaps, the least understood, and the least capable of being explained, of any process connected with iron manufacture. The iron is kept in a fluid state in contact with carbonaceous matter exposed to a blast, and, although it would seem that by such means more carbon *ought to be combined* with the iron, experience shows that a great change is produced in the nature of the metal, and that, as far as we know, the *quantity* of carbon is *diminished*, and the iron rendered more nearly akin to malleable iron, or at least so altered as to be more quickly converted into it.

Refining is an expensive process, great waste of material being unavoidable, but it is still necessary for certain descriptions of iron, and the expense is partly compensated by the greater quickness with which the conversion takes place in the puddling furnace.

Puddling is the last and most important process in the conversion of cast into malleable iron. It is still an extremely rude one, and its theory is not understood; it consists in melting, in a peculiarly constructed air furnace, refined or cast iron, or a mixture of them, and, as soon as the fusion is complete, in continually stirring the melted metal till spicular or granular particles show themselves. Previous to this the melted metal swells up, and what is technically called boils; gas is evolved, and this appears to be the period at which conversion commences: the solid particles increase in quantity, and the whole mass acquires a semi-solidity; the workman keeps collecting the more solid portions and forming them into balls, which become larger and larger, until the whole of the malleable iron is collected, and nothing remains but what is called cinder, in a perfectly fluid state, which is afterwards removed from the furnace by tapping, and again used in certain proportions along with ore in re-

producing cast iron. On the removal of this cinder from the iron, by puddling, squeezing, and rolling, the quality of the resulting wrought iron very much depends.

To avoid the process of refining, to shorten the process of puddling, and to improve the quality of the resulting wrought iron, are, undoubtedly, most desirable. The writer has endeavored to accomplish this, and has reason to believe that partial success has attended his efforts. Instead of using refined iron, a mixture of wrought and cast iron (as already described) is taken, and, after being melted and run into pigs or slabs of the requisite size, it is puddled in the usual way, and the process of puddling is found to be thus so shortened, as to allow of from one to two heats more being brought out, in the course of the twelve hours; the yield is greater, and the quality of the iron is much improved, as regards fibrousness and tensile strength, rendering such iron particularly well adapted for cable iron, tension bars, shaftings, axles, &c., but not for the wearing surfaces of rails, nor for the tires of wheels.

(To be Continued.

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*Electro-Telegraphic Development.**

The extent of telegraphic communication completed and in operation throughout the world at the beginning of the present year may be estimated, as far as can be gathered from the returns, at nearly 40,000 miles. Of this amount there were nearly 4000 miles in Great Britain, of which 100 miles only were underground, with about 400 or 500 miles in course of construction in England, Scotland, and Ireland, and as many more projected. In America there were 20,000 miles of telegraph completed and in operation, with 10,000 more in process of construction, uniting in one great network the principal cities of the United States, the Atlantic and Pacific Oceans, and the extreme boundaries of that extensive continent. In Europe there were about 11,000 or 12,000 miles of telegraph in operation, and as many more projected or in progress. In Germany there were 3000 miles completed, in Austria 3000, and in Prussia between 3000 and 4000 miles. France, until lately in the rear of other nations, is now extending her telegraphic lines in all directions, her completed mileage at the present moment being small compared with that of other countries, her principal communications being those between London and Paris, Strasburg, and Marseilles. Russia has just commenced her system of telegraphs between St. Petersburg, Moscow, and Cracow, and the ports on the Baltic and Black Seas. In addition to her existing line between Naples and Gaeta, Italy is continuing the Neapolitan line from Terracina to Rome, so as to connect with the lines of Upper Italy. Denmark has about 400 miles of telegraph; Belgium 500, and the Netherlands line has just been completed from Amsterdam to the Hague. About 4000 miles are about to be constructed in India. Switzerland is introducing the instantaneous communicator, as well as other continental cities, so that the only unsupplied portions that will soon present themselves on a telegraphic map of the world will be Australia, Africa, and China.—*Advertiser.*

* From the London Mechanics' Magazine, January, 1853.

For the Journal of the Franklin Institute.

Particulars of the Steamer San Francisco.

New York.—Hull by Wm. H. Webb; machinery by the Morgan Iron Works. The engines and boilers were designed by Mr. Miers Coryell, Engineer of the Morgan Iron Works. Intended service, Pacific Ocean.

HULL.—Length on deck,	286 feet.
Breadth of beam,	41 "
Depth of hold,	16 "
" " to spar deck,	24 "
Length of engine and boiler space,	104 ft. by 15 ft. in width, including passages.
Draft of water at pressure and revolutions, given below,	11 feet 6 inches.
Area of immersed midship section at this draft,	443 square feet.
Capacity of coal bunkers, in tons of coal,	500
Draft of water at load line,	13 feet 6 inches.
Floor timbers at throats, moulded	16 "
do. do. sided,	16 "
Distance of frames apart at centres,	3 "
Masts and rig,	Foretopsail schooner.
ENGINES.—Two inclined oscillating.	
Diameter of cylinders,	65 inches.
Length of stroke,	8 feet.
Maximum revolutions per minute,	22
BOILERS.—Two, round shell and drop flued.	
Length of boilers,	34 "
Breadth of boilers,	13 " 6 inches.
Height of boilers, exclusive of steam chimney,	13 " 6 "
Number of furnaces,	4
Length of grate bars,	7 "
Number of flues,	24
Internal diameter of flues, 1st range 16 inches, 2d range 21½ inches, 3d range 17½ to 15 inches.	
Diameter of smoke pipes, (two,)	4 feet 4 inches.
Height of smoke pipes,	30 "
Maximum pressure of steam in pounds,	20
Description of coal,	Bituminous.
Area of flue and fire surface in boilers,	6000 feet.
WATER WHEELS.—Feathering.	
Diameter,	28 "
Length of blades,	8 "
Depth of blades,	4 "
Number of blades,	14

Remarks.—The engines have two piston rods each, and connect to one crank pin, dispensing with the centre shaft; are on wrought iron frames. The air pumps are worked by an independent engine; Pirsson's fresh water condenser; air tight fire rooms.

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*Roasting by Gas.**

During the past week, two trials have been made on a large scale of practice, at Greenwich Hospital, under the direction of M. Soyer, the distinguished professor of the gastronomic art, to ascertain the economy of roasting by gas. The experiments were made in the presence of the

* From the London Mechanic's Magazine, March, 1853.

Governor, Sir C. Adam and lady, Sir J. Liddle, M. D., Lieutenant Rouse, General-Superintendent, Lieutenant Monk, and Messrs. Lee and Seville, Inspectors of Works; and the apparatus employed was one constructed by and under the patent of Messrs. Smith and Phillips, of Skinner street, Snow hill; which was noticed in No. 1473 of the *Mechanic's Magazine*.

The first experiment took place on the 8th inst., when thirty-six legs of mutton, weighing together 288 lbs., or on an average 8lbs. each, were roasted at a cost of fourteen pence. This result being conclusive on the general question of economy, it was determined to have a further trial, in order to ascertain the merits of the principle in detail.

The second experiment was tried accordingly on the 11th inst., on which occasion equal weights of mutton were cooked; and the following results were obtained:—Twenty-three joints, weighing 184 lbs., were roasted at a cost of 10½d., with gas supplied at 4s. per 1000 feet. When cooked, the above weight of meat was found to weigh 145 lbs., dripping 19 lbs., and gravy, or osmazome, 2¾ lbs.; thus showing the actual loss to be 18¾ lbs. Twenty-three joints of mutton were also cooked in the usual way, as adopted at the Institution; namely, in one of the Count Rumford's ovens, hitherto considered the most economical. When put in they weighed 184 lbs., when done 132 lbs., dripping 18 lbs., gravy none; thus showing a loss of 34 lbs. The coke consumed in this oven was 102 lbs., coal 30 lbs.—thus proving the great economy of gas over the oven by a saving of 13 lbs. of meat, 1 lb. of dripping, 2¾ lbs. of gravy. The value of the saving is as follows:—Meat, at 6d. per pound, 6s. 6d.; dripping, at 5d. per pound, 5d.; and gravy, at 1s. 6d. per pound, 4s. 1½d.; making a total of 11s. 0½d.

The saving in time and trouble appears still more remarkable; for the gas being lighted, the dome of the apparatus is opened, and the meat put into it, when it is again closed. M. Soyer and every body retires from the kitchen, which is locked up, and allowing two hours and twenty minutes for the cooking, it is found perfectly effected. All the authorities of the hospital present, and the connoisseurs, expressed themselves extremely well pleased at these satisfactory results.

For the Journal of the Franklin Institute.

U. S. Screw Steamship Princeton. By B. F. Isherwood, Chief Engineer U. S. Navy.

Continued from Vol. xxv., page 385.

The Screw as an Auxiliary.—In 1845, May 6th, the *Princeton*, cruising in company with the U. States first class corvettes *St. Marys* and *Saratoga*, and the brig *Porpoise*, the former accounted an extraordinary fast sailer, made a trial for the purpose of ascertaining what pressure of steam, what number of revolutions of the screw, and what weight of coal would be required in addition to her sails, to beat her consorts.

At 9 A. M., started fires in the furnaces and signalled the squadron to make sail. The *St. Marys* and *Saratoga* set royals and steering sails alow and aloft, both sides. At 10 h. 30 m., A. M., all the squadron

were ahead of the *Princeton;* at 10 h. 40 m., started the engines of the *Princeton;* at 11 hs., A. M., passed the *Saratoga* with 8 lbs. of steam, screw making 18 revolutions per minute. Overhauling the *St. Marys*, she being four miles ahead; at 12, M. the *St. Marys* was between two and three miles ahead; at 1 h. 30 m., P. M, the *Princeton* hauled up to speak a ship about six miles distant; overhauled and spoke her, then kept away for the squadron, setting all the port steering sails. At 7 hs. 30 m. P. M., passed the *Saratoga* and *Porpoise*, they being under a press of sail; at 8 hs. 30 m., P. M., passed the *St. Marys*, she having shortened sail.

The following table gives the absolute performance of the *Princeton* during this trial; the engines being much throttled:

Hours.	Steam pressure in boil. in lbs. per sq inch above atmosphere.	Revolutions of the screw per minute.	Pounds of anthracite coal burned per hour.	Speed of the vessel pr hr. in knots of 6082⅔ feet.	Slip of the screw in per cent. of its speed.
11	8	18	4000	5¼	0·17
12	5	17½	2000	7	25·00
1	5	18½	900	7	18·24
2	5	19	900	7	15·14
3	10	26	900	5	39·90
4	6	21	900	5	25·59
5	5	20	276	8	25·00
6	5	20	276	8	25·00
7	13	24	400	8	4·17
8	8	18½	400	8	35·14
9	5	19	none.	7	15·14
10	1	15	none.	5	4·17
Means	6⅓	19·71	912⅔	6·73	0·42

The above trial shows that from 9 A. M., when the engines were started, the consumption of coal was 4 tons and 1992 pounds up to 10 P. M. When the fires were drawn, by which, with the aid of her sails, the *Princeton* was enabled to beat the squadron, the speed of the screw was on an average the same as the speed of the vessel, but (owing to the following current in the wake of the vessel) it was probably giving a considerable propulsive effect.

On May 8th, 1845, a trial was made to ascertain whether the *Princeton*, under sail, would, with the aid of her steam, beat the other ships of the squadron; and whether she could tow the brig *Porpoise* as fast as the others could sail, and at what consumption of fuel. And to determine, also, whether the *St. Marys* or *Saratoga* was the fastest sailer under the circumstances, there being a good royal breeze and smooth water; course steered, W. by N. ¼ N.; Wind, N.

At 11 o'clock A. M., the *St. Marys* and *Saratoga* were abeam of each other; they made sail to royals and flying jib, starboard topmast and topgallant steering sails; the *Porpoise* being a mile ahead and under all sail. The other ships being abeam of each other were ordered to make all sail, and proceed to Galveston, Texas, (about 650 miles distant,) as soon as possible. The *Princeton* remained one mile behind the squadron, when

she made sail, and with 10 pounds of steam, 17½ revolutions of the screw per minute, and 900 pounds of coal per hour, easily beat them all; speed 7 knots per hour; slip of screw, 25 per centum. On passing the *Porpoise*, she took a tow line from that vessel, and commenced the second trial of speed with the other ships.

The *Princeton* took the *Porpoise* in tow at 12 hs. 30 m. P. M., the *Princeton* being under topgallant sails, starboard fore topmast and fore and main topgallant steering sails; the *Porpoise* was under same sail. The *St. Marys* was three miles ahead, and the *Saratoga* one mile and a-half ahead. At 1 h. 50 m. P. M., the *Princeton* was abeam the *Saratoga;* at 3 hs. 35 m. P. M., the *Princeton* was abeam the *St. Marys*, the *Saratoga* being three miles astern and a mile and a half to leeward. At sundown the *St. Marys* was about five miles distant on the lee quarter; the *Saratoga* about nine miles distant; the *St. Marys* about four miles ahead of the *Saratoga*. At daylight the *St Marys* was eight miles distant astern, the *Saratoga* not in sight. At noon the *St. Marys* was twelve miles distant; at sundown out of sight. The mean performance during the towing of the *Porpoise* was as follows, viz: steam pressure in boilers, 10·3 pounds per square inch above atmosphere; revolutions of the screw per minute 27·6; pounds of anthracite coal consumed per hour, 1656; speed of vessel per hour, 8·847 knots; slip of the screw, 0·36 per cent.; maximum speed while towing, 10 knots; minimum speed while towing, 8 knots per hour.

On the 17th June, 1846, a short race was tried between the *Princeton* and the U. S. brig *Somers*, a vessel considered to be a very fast sailer. The brig was under all sail, from royals to courses; the *Princeton* was under similar sail, except topgallants, royals, and flying jib. Both vessels were close hauled, and standing on the same tack, separated by only a few hundred yards; the sea was perfectly smooth, and the wind a fine working topgallant breeze.

After speaking the brig, she stood off under all sail; the *Princeton* then went off, set topgallant sail, and stood after her; by this time the brig was about 400 yards ahead; in 15 minutes the vessels were square abreast, the *Princeton* shooting ahead fast; when the race was discontinued, and the *Princeton* hauled up to cruise. During the race, the *Princeton* used the centre boiler only, there being neither steam nor fires on the two wing boilers; the steam pressure was 6 pounds per square inch in the boilers, cut off at ⅓d stroke from commencement; throttle $_3{}^1{}_2$d open; revolutions of the screw per minute, 17. Speed of the *Princeton* during the race, 8¾ knots per hour; during the last few minutes she was gaining on the brig at the rate of about 100 feet per minute. Draft of *Princeton* during race, 15 feet 4 inches forward, and 18 feet 8 inches aft; slip of the screw, 60·85 per centum; consuming at the rate of 400 pounds of anthracite per hour.

The screw as an auxiliary, proved exceedingly efficient when the *Princeton* acted as a blockading vessel off the port of Vera Cruz during the Mexican war. While thus employed, she would lay off and on some six miles distant from the city, under easy sail, with the fires banked in the furnaces of the centre boiler only, the steam stop valves being closed; with the wing boilers, about 6 lbs. of steam was kept on. When a vessel was descried, the fires in the centre boiler were spread, fresh coal

thrown on, and the fan blast started; in fifteen minutes the generation of steam would allow the use of the engines, and by the addition of a slight power from the screw to the sails, the speed would become sufficient to overhaul any vessel. In a calm or in a very light head wind, the steam from the centre boiler alone would supply the engines with 12 lbs. boiler pressure for 16½ revolutions of the screw; throttle, $\frac{1}{16}$th open; cut off, ⅓d stroke from commencement; back pressure in condenser, 3·2 lbs. pr sq. in; speed of vessel, 3¾ knots per hour; consumption of anthracite coal, 700 lbs. per hour, with the fan blast driven violently. During sixteen successive days the fires were thus kept banked on the centre boiler, spreading and using them occasionally when a chase hove in sight; there was consumed a total of 32,960 lbs. of anthracite, or 2060 pounds per 24 hours.

Under the above circumstances, in the month of June, 1846, off Vera Cruz, the temperatures of the wing boilers from radiation and leakage through the stop valves from the centre boiler, was 160° F., and 140° F.; temperature of coal bunkers immediately over boilers, 104° F.; temperature of engine room at 10 feet from front of boilers, 115° F.; temperature on deck averaged 90° F., of water, 80° F. The boilers were covered with one thickness of felt, on which was placed a sheet iron casing, over which came a wooden casing, covered in turn by a last one of sheet iron. The sides of the wing boilers formed the sides of the bunker, and the coal was thrown against them.

The Princeton without steam, as a sailing vessel only.—The screw of the *Princeton* was fitted with a simple clutch coupling, which by a lever could be thrown in or out; when out, the screw revolved by the pressure of the water against it, caused by the progress of the vessel, and opposed much less resistance to the speed of the vessel when under sail alone than if it had been dragged in a fixed position. The *Princeton* frequently sailed in this manner, and the following table gives the performance:

Performance of the U. S. Screw Steamship Princeton under sail alone, with the Screw uncoupled, and revolving in the water by the progress of the vessel, embracing all the sailing found recorded in the Logs at the Navy Department.

Number of hours.	Speed of the vessel pr hr. in knots of 6082¾ feet.	Wind.	
		Direction.	Kind.
158	3·966	Forward the beam.	Light breeze.
99	5·000	" "	Moderate "
42	5·454	" "	Fresh "
202	3·265	Abeam.	Light "
211	5·794	"	Moderate "
207	6·345	"	Fresh "
153	4·606	Aft the beam.	Light "
142	6·451	" "	Moderate "
24	7·417	" "	Fresh "
Mean speed under sail alone.	5·125		

The above table sufficiently explains itself, and it is only necessary to add that the maximum speeds under sail alone were as follows, viz: 212 geographical miles made in 24 hours during August 3d, 1845, or 8·833

knots per hour. Course of vessel, S. W., wind E. and moderate, with a smooth sea and all sail set.

During 12 hours of July 25, 1847, made 122 geographical miles, or 10⅛ knots per hour. Course of vessel, E. by S.; wind, a fresh breeze from southward and westward, with smooth sea and all sail set.

During the 24 hours of July 29, 1847, made 221 geographical miles, or 9·21 knots per hour. Course of vessel, direction and strength of wind, sail, sea, &c., same as on the 25th inst., immediately preceding.

When the vessel was under sail alone, the screw being uncoupled and revolving by the pressure of the water, its revolutions, compared to the speed of the vessel, were for a mean of several thousand observations, as follows, viz:

The Ericsson screw made 1·9700 revolutions per minute for each knot per hour of the vessel's speed. The Stevens screw made 2·2934 revolutions per minute for each knot per hour of the vessel's speed. Per unit of vessel's speed, therefore, the revolutions of the Ericsson and Stevens screws were in the ratio of 1·0000 to 1·1642. The pitches of these screws were in the ratio of 1·0789 to 1·0000, or nearly in the inverse ratio of their revolutions.

The screws would not revolve with a less speed of vessel than two knots per hour, but the ratio of their revolutions to the speed of the vessel was sensibly the same, whether that speed was 3 knots or 10 knots per hour.

Taking the average speed of the vessel under sail alone, at 5·125 knots per hour, the revolutions of the Ericsson screw would be 10·0963 per minute, making its speed 3·486 knots per hour, at which rate the speed of the vessel would exceed it by 1·639 knots per hour, or the speed of the vessel would be greater than that of the screw by 47·00 per centum of the latter.

Taking the speed of the vessel at the same, 5·125 knots per hour, the revolutions of the Stevens screw would be 11·7537 per minute, making its speed 3·761 knots per hour, at which rate the speed of the vessel would exceed it by 1·364 knots per hour, or the speed of the vessel would be greater than that of the screw by 36·27 per centum of the latter.

It must, however, be considered that by the passage of the vessel through the water there is generated a following current of considerable speed, and that the speed of the screw under the above circumstances must be compared, *not* with the speed of the vessel through the water, but with that speed *less* the speed of the following current. The speed of this following current it is impossible to determine; but with hulls of good model at medium speeds, it may be estimated at about one-fifth the speed of vessel. If, therefore, we make a deduction of one knot from the speed of vessel, (5·125 knots per hour,) it leaves a speed of 4·125 knots of vessel to be compared with a speed of Ericsson's screw of 3·486 knots per hour; and of Stevens' screw of 3·761 knots per hour; on which assumption the retardation of the vessel's speed would be equal to the effect of a power required to drag the Ericsson screw (not revolving) through the water at a rate of 0·639 knots per hour, and the Stevens screw at a rate of 0·364 knots per hour. The resistance of the screw thus dragged would not equal that of a disk of the same area, inas-

much as the screw surface is not placed at right angles, but obliquely to the direction of motion; and as the effect of power on speed is as the cube root of that power, it will be perceived that the *drag* of the screw, or the retardation of the vessel's speed by it, must be very little indeed, probably in the majority of cases not sensible to the log. In confirmation of this result, I find in *Bourne's Treatise on the Screw Propeller*, page 142, where the conclusions of the French experimenters on the screw vessel *Pelican* are cited, the following recommendations, viz: "but in the case of merchant vessels with auxiliary power, they recommend that the screw shall be made merely capable of revolving freely when disengaged from the engine, in the manner of a patent log. A screw thus fitted, will, they say, offer scarcely any obstruction to the progress of the vessel under sail, while it will possess advantages in strength and simplicity, such as would not be otherwise attained." In the last and most perfect screw vessels of the French Navy, as the *Napoleon* for instance, a screw of four blades is used, incapable of being hoisted out, as in the British Navy, where two bladed screws are wholly used; this number of blades being imperative where the screw is to be hoisted out. In the *Napoleon* the screw is simply uncoupled as in the *Princeton*, when it is desired to navigate the vessel with sails alone.

In addition to the mere *drag* of the screw just stated, there is a further retardation of the vessel's speed due to what is usually termed the screw's friction on the water; this is probably greater than the former. In the absence of all exact experiment, it is impossible to determine the value of these retardations, but I am persuaded it does not exceed one-tenth the vessel's speed; that is to say, a vessel which, disencumbered from the screw, would make 10 knots under sail, would make 9 knots dragging it.

In the following tables of the performance of the *Princeton*, there will frequently be found what is called *the negative slip of the screw. This, however, only occurs when the vessel is under sail and steam; it never occurs under steam alone.* When it has place it is indicated by the minus (—) sign prefixed. By negative slip of the screw is meant the excess of the vessel's speed over the forward speed of the screw (revolutions multiplied by pitch) in per centums of the latter. Under these circumstances it might be supposed the screw, so far from assisting, was retarding the vessel's speed. Such, however, is not the case, owing to the facts of the screw being located at the stern, and the generation of a following current of considerable velocity by the advance of the vessel; this current flowing in behind the stern, supplies chiefly the water on which the screw acts, and it may be slipping considerably in this water and yet apparently have less speed than the vessel.

Boilers.—The *Princeton* had two sets of iron boilers. The first set was designed by Ericsson; the second set by Chas. H. Haswell, at the time Engineer in Chief U. S. N. Both sets corroded out very rapidly. The first set underwent very extensive repairs in Dec. 1846, 2 years and 10 months after they were built, and they were taken out in April, 1847, 3 years and 7 months after they were built, so completely corroded out as to be impossible of repair. The last set on their return to the United States after two years' service were found to be greatly corroded.

The corrosion of the first set of boilers was greatest on the semi-circular

top of the shell above the water line, though the whole water surface was severely acted on. The top of the shell was not acted on in particular places, nor did the metal present honeycombed or pitted appearance, but the wasting seemed uniform over the whole extent. The reason was at the time a subject of general speculation, but none of the causes offered met the case. After the breaking up of the vessel, and the removal of the machinery, I had occasion to minutely examine the latter, and I found the brass feed pump of the port engine, its valves, valve seats, and valve chests, also of brass, in a completely corroded condition; the whole surface being honeycombed or pitted very thickly and very deeply, extending in many places nearly through the ⅜ths inch thick metal. On examining the corresponding feed pump of the starboard engine, made of the same material, similarly situated and performing the same office, I was surprised to find it in excellent order, with no marks of corrosion. At first I was at a loss to account for this difference, but upon reflection, recollected the *Princeton's* engines had no independent *bilge* pump, and that when under way the bilge water, which made very fast, (owing to a steady stream being admitted through the pipe surrounding the propeller shaft where it passed through the dead wood of the vessel, for the purpose of keeping cool and lubricating the stern bearing of the same shaft,) was taken out of the ship by a bilge injection, communicating with only the port engine, air pumps, and reservoir; the starboard engine having no bilge injection. Of course, the water fed to the boilers by the port engine pump, and the pump of each engine fed to all three boilers, was greatly mixed with bilge water, composed of sea water strongly impregnated with the acids and soluble matters of the green white oak of which the chief part of the vessel was made; and as these acids appeared to have had sufficient strength to attack and destroy the brass of the pump, it is highly probable they were also the cause of the far more rapid destruction of the iron of the boilers. In connexion with the foregoing I will also state, that no scale was made upon the fire surface of the boilers during the year I was attached to the vessel in the capacity of engineer, while steaming in the Gulf of Mexico, although the water in the boilers was never carried at less than twice the natural concentration, and frequently for days at two and a-half times the natural concentration, the steam pressure ranging from 10 to 12 lbs. per square inch. Although every part of the fire surface of the first boilers could be reached, and the scale jarred off had there been any there, yet there never was found enough to make the operation of *scaling* necessary. The U. S. steamship *Mississippi*, steaming at the same time in the same waters with copper boilers, made scale to a very inconvenient extent, with the water in the boilers carried at only one and three-quarters the natural concentration, with about the same pressure of steam. The *Mississippi* made scarcely any water, was built of seasoned live oak, and had independent bilge pumps. I ascribe the remarkable cleanness of the *Princeton's* boilers to the dissolving of the scale by the acid of the bilge water, and also to the continual falling off of the scale by the continual removal of impalpably thin layers of the iron by the action of these acids. In the engine room of the *Princeton*, the stench from the bilge water was overpowering.

Both sets of boilers were utterly inadequate to supply the engines with the steam of proper pressure they could work off, cutting off at ⅛d the stroke from the commencement. By proper pressure, I mean 20 pounds in the boilers per square inch with wide throttles. The most violent forcing with the fan blast could not effect a reasonable approach to this; nor could there be maintained, for 24 or 36 consecutive hours, by any practicable amount of forcing the fires with the blast, over 10 pounds of steam, with the throttle half open, and cutting off at ⅛d. Much smaller engines could have worked off all the steam the boilers could supply, and of course could have developed the same power.

In calculating the evaporation of the boilers, I have confined myself to the steaming done after Commodore Stockton resigned the command, both because the data was sufficiently large, and because for that time only were the steam logs complete in all the elements; also, because the selection of the fuel was made with greater care while the vessel was making experimental trials. In calculating evaporation, Regnault's data for the latent heats of steam is used. In order to burn from 1200 to 1400 pounds of coal in either set of boilers, the steam pistons of the blowing engines were required to make about 30 double strokes per minute. These engines were two in number, with cylinders of 12 inches diameter, and 14 inches stroke of piston, the exhaust communicating with the condensers of the large engines. Worked by each blowing engine was a centrifugal blower of 4 feet diameter, composed of six fans 22½ inches long by 12 inches deep; the blower was geared up with a belt, to make six revolutions for each double stroke of the steam pistons, the average being 180 revolutions per minute. With wide throttles, the pistons of the blowing engines would make 200 double strokes per minute. These engines were much larger than was required or could be used. The natural draft of both sets of boilers was very defective; the utmost of anthracite that could be burned with it was 6 pounds per hour per square foot of grate surface, or about 800 pounds per hour.

The economical evaporation of these boilers was only up to the ordinary standard. There was in both much too little heating surface for the fuel consumed, and the heated gases, especially with the first boilers, were delivered into the smoke chimney at a very high temperature. I have witnessed on a dark night, when using soft anthracite, and forcing the blowers strongly, a mass of dense red flame driven out from the top of the chimney, of its full diameter, and rapidly. On one occasion when forcing the vessel, this mass of red flame was of sufficient volume to stream over the taffrail, and brightly light up the decks around, alarming the officers of the ship, and requiring the cessation of the blowers.

The last boilers were superior in type to the first. They contain a considerably greater amount of heating surface in the same sized shells, and gave much higher economical results; but they were inaccessible for cleaning or repairs, while every part of the first boilers could be reached.

First Boilers.—Three iron boilers, with one tier of deep return flues. The boilers are placed side by side, with one smoke chimney in common.

Length of each boiler,	. . .	26 feet.
Breadth	"	7 "
Height	" . . .	9 " 4 inches.

Area of the total heating surface in the three boilers,	2420 square feet.
" " grate " " "	134 "
Aggregate cross area of the direct flues "	27,120 "
" " return " "	15,708 "
Cross area of the smoke chimney,	13,635 "
Height of the smoke chimney above the grates,	32 feet.
Capacity of steam room in the three boilers,	1222 cubic feet.
" " " steam pipes, &c.,	1297 "
Weight of sea water in the three boilers, (12 inches above top of flues, weighed,)	76,160 pounds.
" of the three boilers, &c., complete,	128,128 "

PROPORTIONS.—Proportion of heating to grate surface, 18·060 to 1·000.

Proportion of grate surface to aggregate cross area of the direct flues,	4·941 "
" " " " return "	8·531 "
" " to cross area of smoke chimney,	9·828 "
Square feet of heating surface per cubic foot of space displacement of piston per stroke,	22·368
" grate " " "	1·239
Cubic ft. of steam room per cubic ft. of steam used per stroke of piston,	24·050

LAST BOILERS.—Three iron boilers, with double return, drop, circular flues. The boilers are placed side by side, with one smoke chimney in common.

Length of each boiler,	26 feet.
Breadth "	7 "
Height "	9 " 4 inches.
Area of the total heating surface in the three boilers,	3000 square feet.
" " grate " "	136 "
Aggregate cross area of the upper row of flues in the three boilers,	18·363 "
" " middle row " "	16·762 "
" " lower row " "	16·762 "
Cross area of the smoke chimney,	13·635 "
Height of the smoke chimney above the grates,	40 feet.
Capacity of steam room in the three boilers,	949 cubic feet.
" " " steam pipes, &c.,	1024 "
Weight of sea water in the three boilers, (calculated,)	88,860 pounds.

PROPORTIONS.—Proportion of heating to grate surface, 22·059 to 1·000.

Proportion of grate surface to aggregate surface of upper row of flues,	7·046 "
" " " cross area of middle " "	8·114 "
" " " " lower " "	8·114 "
" " " " smoke chimney,	9·974 "
Square feet of heating surface per cubic foot of space displacement of piston per stroke,	27·729
" grate " " "	1·257
Cubic ft. of steam room per cubic ft. of steam used per stroke of piston,	18·990

(To be Continued.)

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*Stenson and Co.'s Patent Welding Hammer.**

Compact soundness and homogeneity in wrought iron, are desiderata which practical men connected with engineering and smith work in general, have long sought after. But iron being subjected, during forging, to every variety of torsion, punching, and other tests, in the multiform uses to which it is made subservient, any defect occurring by cleavage or splitting while in the hands of the workman, is a direct loss both in time and material. Every improvement, therefore, in the welding, and greater uniformity in the character of the iron, cannot fail of being highly appreciated.

* From the London Mechanic's Magazine, March, 1853.

When bars made from "piled" iron, imperfectly welded, are used as piston or other rods, working through stuffing-boxes, longitudinal seams or lines of cleavage are frequently apparant throughout their length. The edges of these dark lines are usually rough and serrated, and are the too frequent causes of premature destruction to the hempen packings through which they work.

Defects in the welding of piled iron are also frequently manifest in the cleavage and lamination of the tyres on carriage wheels. It is no uncommon thing to see the tyre of a coach-wheel, after having only been a short time at work, and when but one-fourth or one-sixth worn, split and divide like the leaves of a book—a defect which at once renders its replacement indispensable. A compact iron was formerly produced in the "Catalan forge," or "Bloomery fire;" the fuel used being charcoal, which was supplied from the extensive woods then abounding in many parts of England.

By means of this private process, iron was made directly from the ore, and brought out of the fire in a solid mass, which, by being repeatedly heated and hammered, was ultimately reduced to the size and form required. But as those ancient woods became exhausted, the iron manufacture gradually retired from its former localities, and took its position chiefly in those districts where the coal-fields offered a cheap and abundant supply of fuel. The iron made by coke, however, though produced at a cost greatly below that of the charcoal forges, was found to be of a quality so inferior to that of the latter as to render improvement not only desirable, but indispensable to a successful competition and an abundant production.

The conversion of pig into malleable iron, by the process of "puddling," as invented by Cort, was an important step towards the desired end; but the iron thus made was found to be of a weak nature, known by the term "cold-short," more especially when the pig had been produced from ores containing an excess of silicon, phosphorus, sulphuret of iron, or other foreign matters.

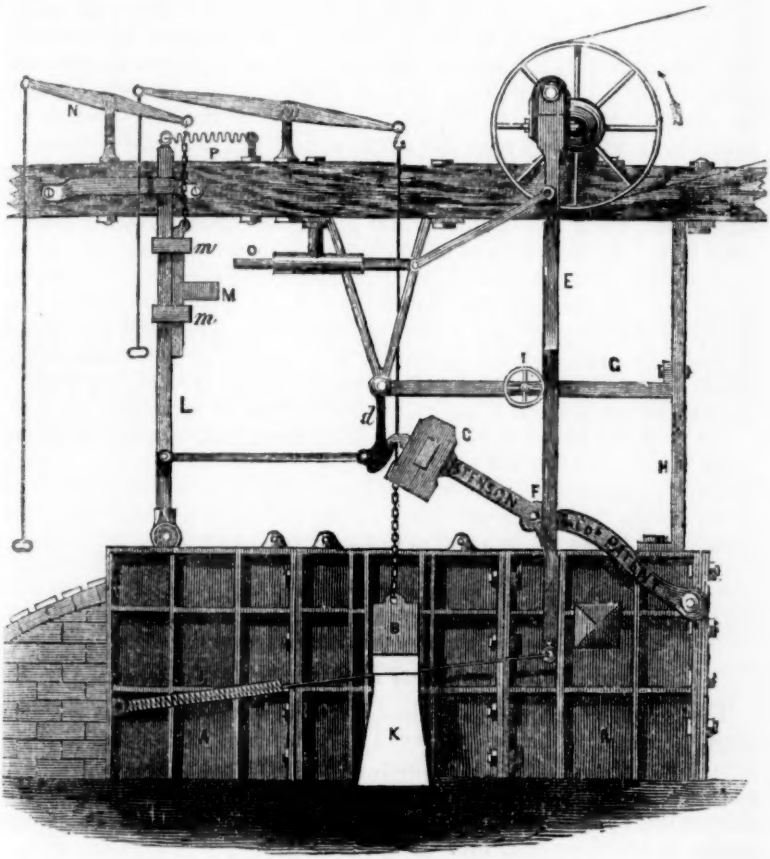
With a view to the production of a more fibrous character in the iron, came next the "doubling and welding," or "rolling" the puddled balls, after they had been hammered, into "rough bars" or "puddled bars"—a method now so generally adopted in our iron works. These puddled bars, being cut to the required lengths, are placed one upon another, and formed into "piles," which may be composed of from two or three to eight or ten plates. The furnace is now charged with as many of these piles as may be convenient, and when they are at a high welding heat the drawing and rolling of the charge commences.

The object effected by means of the patent process is a more perfect welding of the pile into a solid mass than has hitherto been accomplished; this preventing cleavage or lamination either in forging or in wear.

The usual method is to take the pile out of the furnace and draw it to a considerable distance along the floor to the rolls. During this time, the air acting upon and between the plates composing the pile, produces an oxidation and a cooling of the iron, which renders the welding imperfect. But by the patent process the welding is effected at the instant the pile

leaves the furnace, after which it is passed through the rolls in the usual manner.

The engraving represents Stenson and Co.'s Patent Welding Hammer, as used at the Patent Iron Scrap Forge-Works, Northampton.



A A is the reverberatory furnace, in which the iron is heated previous to being rolled into finished bars. B the furnace-door, which is lifted by a lever. C the patent hammer, resting upon a catch, *d*. E a lifting-rod, which is in constant motion, and provided with a catch for lifting the hammer by means of the stud at F. G a stay which carries the friction roller, I; this roller is the fulcrum on which the edge of the lifting-rod, E, vibrates. The lifting rod is pressed up to the roller by means of the spring, J. H, a vertical stay from the top of the furnace to a beam overhead, which carries the driving-pulley, levers, &c. K, a cast-iron block, about 12 inches square and 2 feet high, supporting an anvil, the face of which

is level with the heating-floor of the furnace. L, a vertical lever, the lower end working in a joint, and the upper end made to vibrate when pushed back by the sliding bolt, O, and brought back to its place by the spring. M, a slide working between two guards, *m m*, and lifted by means of the lever, N. When the door, B, is raised, and a pile of fire brought out of the furnace upon an anvil, the slide, M, is lifted, and is then pushed back by the bolt, O, by which the catch, *d*, is also thrown back, and the hammer immediately falls upon the pile as it is drawn from the mouth of the furnace, and strikes one, two, or more blows, as may be required, until the slide, M, is allowed to fall below the action of the bolt, O, when the hammer, C, again rests upon the catch, *d*, until the next pile is drawn.

Hammers of various weights are used, according to the size of the iron in course of manufacture; a head of 50 pounds being found sufficient for small piles, while one of 200 or 300 pounds is necessary when making large iron. In the works of the patentees, who manufacture from scrap-iron—which, from its more fibrous character and greater toughness, requires more hammering than that of the ordinary quality as puddled from pig-iron—this large weight is always employed. The effect is produced by simple means, and the machinery is propelled by the steam engine which drives the rolling mill. The hammer, when at work, has a fall or compass of about 2 feet 6 inches, which is found to be sufficient.

Not only is a sound weld secured, but a considerable saving is effected in the manufacture by the use of this hammer; as the pile, being struck while at its greatest heat, is rendered into a solid mass, which prevents the over-drawing during the process of rolling into bars, and thus saves the greater part of the waste usual in cropping the rough ends at the shears.

For the Journal of the Franklin Institute.

Description of the Steam Fire Engine at Cincinnati.

The following description of the Cincinnati steam fire engine has been communicated for the *Journal* by T. W. Bakewell, Esq., who obtained it from Mr. A. B. Latta, the builder. We believe no previous authentic account has been published of this machine, which has excited considerable notice, and is probably destined to play an important part in the protection of buildings from fire. COM. PUB.

This machine has been in operation since the 1st of January, 1853, and has proven itself successful beyond all doubt, although the project has been tried before, and set down as impracticable, because it requires a machine that can be brought into operation as soon as hand apparatus. This, with other objections, such as running over rough streets, laying on uneven ground when at work, running up and down hill, and a host of other objections, have been causes for abandoning the use of steam heretofore; but these objections have been completely set aside by the operation of this machine. The first thing of importance in this engine is the principle of generating steam, which is a very old principle, but has not been properly understood heretofore. It is the same that is now being projected by a Frenchman, which he calls a serpentine boiler, which is a con-

tinuous pipe coiled spirally or otherwise, so as to let the fire have a chance to surround it; the water being injected, it is instantly converted into steam; this accounts for the short time it requires to raise steam. This machine resembles a locomotive in some respects; it has cylinders on both sides, placed like those of a locomotive, the pumps being directly forward of the steam cylinders; the piston rods run directly out of the steam cylinders, and enter the pumps; the engines are so arranged as to couple to the driver at pleasure; this is done in order to drive the machine by steam when desired, and to hold back when going down hill, or assist in going up; this is an important consideration; the drivers resemble those of a six wheel locomotive, being aft of the fire box; the forward end of this machine runs on one wheel and revolves round like that of the velocipede, by which means the machine can be turned any where in the length of itself. Another reason why it should only have three wheels is, that its bearings are like those of a three-legged stool; it always comes to a bearing, without straining or twisting the machine; the perfect adaptedness of this combination to suit the circumstances, is the cause of its success. This machine is constructed of iron and brass, except the wheels, which are partly of wood. I believe the worst throwing it has ever made was when it was brought out to throw before the Hope Hose Co. of Philadelphia; I believe it only threw 160 feet; the greatest throw it has ever made is 240 ft. from the end of the nozzle to where the solid body of water fell, through a $1\frac{3}{4}$ inch nozzle; and 291 ft. to where the spray fell. This machine will discharge about 2000 barrels of water in one hour. It throws from one to six streams of water, and has two suctions $6\frac{1}{2}$ inches in diameter, and 24 feet long; each one is in one piece; these are always attached to the engine; they cross each other in front, and lay back on either side; this is a very important improvement, and a saving of time and labor in attaching the suctions. The time required to put this machine in operation is five minutes; it requires four men and four horses to operate it, and will do as much as six of the largest class hand apparatus. This will give the reader an opportunity of estimating the economy in the use of steam for this purpose. Any further information can be obtained concerning it, by addressing A. B. Latta, who is the projector and builder of this machine, at Cincinnati.

Now, by way of illustration, we may notice its performance at one fire, to show the effect produced by this machine, compared with that by the hand apparatus. A fire occurred on the 20th of May, 1853, on Twelfth and Main streets, at 3 o'clock P. M.; the alarm was given, the steam engine ran eight squares, laid her hose, which was one square from the fire, and put the first water on the fire, which was all done in about five minutes; the hand apparatus, notwithstanding there were some of them stationed only two squares from the fire, were not at work until the steam engine was under way. In eight and a half hours' work (making due allowance for waste of water,) she poured into the fire about 15,000 barrels of water; it was a large brewery with sale cellar; the wind was high, and nothing but a cataract of water could have saved the entire square from destruction. This will show what can be done with steam in putting out fires. Arrangements are now making for four more of these machines by the Chief Engineer of the fire department. This will give the fire department of Cincinnati the greatest strength of any in the Union.

A Full-Grown Gasometer.

Some few years since several of the most "eminent engineers" of the day gave evidence before a Parliamentary committee to the effect, that a gasometer of greater diameter than 35 feet would be very dangerous; and recommended that in all cases where this limit was approached, a series of strong walls should be built round the gasholder, in order to lessen the injury which the almost inevitable "explosion" might entail. Although practical men subsequently proved such an idea to be chimerical, no one, that we recollect of, has attempted to make a gasometer at all approaching in size to one described in the *Wolverhampton Chronicle* as having been lately manufactured at Smethwick. Its diameter is 165 feet. By bringing a recent patent to bear upon its construction, the makers have affected a saving of 2000*l.* in raw material, through the absence of the heavy iron frame work which usually supports the roof (if we may so call it) of a gasometer. The top is quite flat, experience having proved that with a certain mode of construction all internal support is superfluous. This gigantic gasometer is intended for the Sheffield Consumers' Gas Company. The manufacturers, Messrs. Horton, are also engaged in manufacturing telescopic gas-holders on a new principle (the subject of another new patent), by which still further economy, it is said, in labor and material is insured.—*London Builder, No.* 532.

Remarks.—The eminent engineers spoken of above must be relatives of the one who swore before a Coronor's Jury, that he recollected distinctly that the explosion of the "big gun," killed Mr. Jefferson. The gas holder of the Philadelphia Gas Works erected in 1850 is 140 feet in diameter and 74 feet high, built on the telescopic principle of course. (*See Journal of the Franklin Institute* 3*d. Ser., Vol.* xxi, *p.* 292). The gas holder now in process of construction at the new works is 160 feet in diameter, and 90 feet high, with a top nearly flat, having only rise enough to carry off the water, and without the usual framing and rafters for sustaining the crown. From the brief description of the Sheffield holder, we should think the two almost identical in construction.

Ed.

For the Journal of the Franklin Institute.

Steam Boiler Explosion at Covington, Ohio.

Our correspondent at Cincinnati, Ohio, under date of May 31st, 1853, says: "The boiler explosion at a Rolling Mill near Covington, presents no feature of special interest. The boiler was cylindrical, 34 inches diameter, (no flue,) wrought boiler plate end, turned at a sharp angle round the edge to form a flanch. The boiler had been leaky at this edge for some time previous, and at the time of explosion was parted from the boiler at the angle all round, converting the boiler into a rocket-like projectile, which flew about 400 feet, and fell into the river. The end shows the character of the rupture."

For the Journal of the Franklin Institute.

United States Auxiliary Screw Steamship Massachusetts. By B. F. Isherwood, Chief Engineer, United States Navy.

The *Massachusetts* was originally built for a steam packet to ply between New York and Liverpool, but not proving a satisfactory speculation, she was next sent to the East Indies, and on her return, the Mexican war being in progress, was sold to the army for a transport. After the treaty of peace she was transferred to the Navy Department, and sent to the Pacific on the California cost, whence she has just returned to Norfolk, Virginia. The abstract of her logs, hereinafter given, comprises the whole of her performance while belonging to the Navy.

The *Massachusetts* was originally designed for purely an auxiliary steam power, to be used only in calms, and when the wind was so light as to give the vessel with sails alone a less speed than 5 knots per hour. With this design, it was necessary to arrange the screw so that it could be hoisted out of the water when the vessel was not under steam. This was accomplished in the manner hereinafter described.

The machinery of the *Massachusetts* was designed by Captain John Ericsson, and cost $24,000. The entire original cost of the vessel, including machinery, was $80,000.

When transferred to the Navy, the *Massachusetts* was fitted with Ericsson's surface condenser, in addition to an ordinary jet condenser kept ready for use when the other was out of order. This surface condenser answered very well for a time, producing a tolerable vacuum and furnishing the boiler with a sufficient supply of fresh water, the loss by leakage &c., which was trifling, being easily supplied by an evaporator. This condenser was essentially the same as Hall's, from which it only differed by the position of the condensing tubes, which were vertical in Hall's, and slightly inclined from the horizontal in Ericsson's. It was found that the very thin tubes composing the condensing surface in the *Massachusetts*, were, though of copper, rapidly corroded out by the sea water, honeycombing over the whole surface; the surface condenser was therefore removed from the vessel, and the steaming recorded in the logs was done with the ordinary jet condenser.

The following are the dimensions of the vessel, machinery, &c.

Hull.—			
Length on keel,		155	feet.
Length on deck,		160	"
Length from forward part of billet-head to after part of taffrail,		178	"
Breadth of beam for tonnage,		31	" 8 inches.
Extreme breadth of beam on deck,		32	" 2 "
Depth of hold,		20	"
Depth of keel and false keel,		23	"
Deep load draft,	Forward,	15	"
	Aft,	16	"
Mean draft for the time of steaming comprised in the logs,		15	"
Area of immersed amidship section at 15 feet draft,		358·4	sq. feet.

Rig.—The *Massachusetts* is ship rigged, and spreads 21,082 square feet of canvass in the principal sails. Her rig is what is known as

Forbes', its peculiarity consisting chiefly in dividing what would be the ordinary topsail by an additional yard into two sails, making as it were double topsails with aggregate surface equal to that of the usual single topsail. This arrangement is obviously for greater ease in handling the sail. From stem to centre of foremast is 31 feet; thence to centre of mainmast 57 feet; thence to centre of mizzen mast 42 feet.

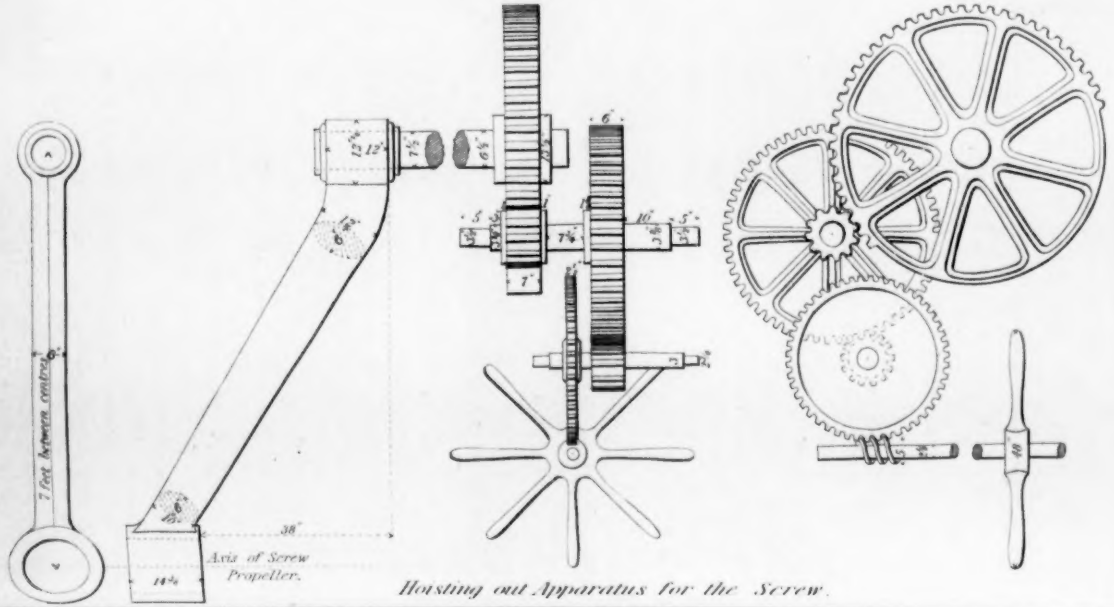
The space occupied by the machinery, coal, &c., extends from the stern post 47 feet; and the bunkers hold 80 tons of coal.

Hoisting out Apparatus of the Screw.—Plate I.—The arrangement by which the screw is hoisted out of the water, consists of a shaft, on which is a capstan or hand wheel of eight arms, measuring 24 in. from the centre of the shaft to the extremity of the arm. This shaft carries an endless screw of $4\frac{1}{8}$ inches on the pitch circle, which works into a wheel of $32\frac{1}{2}$ inches diameter, $2\frac{1}{2}$ inches face, and $1\frac{5}{8}$ inch pitch of teeth. The shaft of this wheel carries a pinion of $8\frac{3}{4}$ inches diameter working into a wheel of $42\frac{1}{2}$ inches diameter, 6 inches face, and $2\frac{3}{16}$ inches pitch of teeth; the shaft of which in its turn carries a pinion of $9\frac{1}{2}$ inches diameter, working into a wheel of $55\frac{3}{4}$ inches diameter, 7 inches face, and 3 inches pitch of teeth. The diameters of all the above pinions and wheels are to their pitch circles. On the shaft of the last wheel, the upper end of the wrought iron lifting arm is keyed, the lower end encircling the projecting portion of the hub. The weight of the lifting arm is 1200 pounds. The screw is not keyed to its shaft, which latter is square in section (with the angles a little taken off to prevent turning,) and merely ships into the hub. The outboard or screw shaft is drawn by levers directly inboard into the hollow part of the next section of shaft, sufficiently far to allow it to clear the hub of the screw; the hand wheel or capstan being then turned by two men, the lifting arm revolves, carrying the screw with it, and by half a revolution lifts the screw out of water, and elevates it perpendicularly 14 feet, where it is secured by locking the gearing and by hooking braces to it from the vessel. When it is required to lower the screw, the reverse operation is performed. It required from 20 to 30 minutes to raise or lower the screw and to secure it ready for sailing or steaming.

By the above arrangement it will be perceived, that in *backing*, the thrust of the screw is communicated by the collar on the hub to the lifting arm; this arm must therefore be made sufficiently strong to hold the thrust against its leverage of 7 feet. In *going ahead*, the thrust of the screw is communicated by the hub to the after end of the shaft; the after extremities of the shaft and of the bore of the hub being tapered to the form of a frustrum of a pyramid.

Screw.—One true screw of bronze. The hub is cast in one piece, and the arms are cast separate and riveted to the hub. The band or drum is cast in six pieces, and riveted by flanches to the arms. It will be observed that these parts of the blades pierced by the rivets are made thicker by raised ribs, in order that the strength of the blades may not be weakened by the riveting. The peculiar form of hub resulted naturally from disposing a minimum quantity of metal most effectually to resist the cross-strain of the blades.

U.S.S. MASSACHUSETTS.



Hoisting out Apparatus for the Screw.

The weight of the screw is 5145 pounds: it makes one revolution to each double stroke of engine piston.

Diameter of screw,		9 feet 6 inches
Diameter of drum (outside),		5 " 2 "
Diameter of hub (circular part),		1 foot 7½ "
Pitch of screw,		20 feet.
Mean fraction of pitch used,		0·633
Length of screw, from hub to drum, in direction of axis,		1 foot 6 "
Length of screw, from drum to periphery in direction of axis,		2 feet 4 "
Helicoidal area of the six arms,	17·111 sq. feet,	
Helicoidal area of the six blades,	47·281 " "	
Total helicoidal area of the screw,		64·392 sq. feet.
Projected area of the six arms on a plane at right angles to axis,	8·808 " "	
Projected area of the six blades on a plane at right angles to axis,	34·465 " "	
Total projected area of the screw on a plane at right angles to axis,		43·273 " "
Radius of the centre of pressure of the screw in function of surface and square of the circumferential velocity of the surface,		3·346 feet.
Distance the centre of screw is below the surface of the water (at 15 feet draft),		6 feet 1 inch.

Engines.—Two direct acting, inclined, condensing engines.

Diameter of cylinders,	25 inches.
Stroke of pistons,	3 feet.
Space displacement of both pistons per stroke,	20·454 cubic feet.
The engines have a steam slide valve, and an independent slide cut-off, cutting off the steam at half stroke.	
Steam space between cut-off and slide valves, at one end of both cylinders,	0·611 " "
Steam space between slide valves and pistons, at one end of both cylinders,	0·531 " "

Boilers.—Two iron boilers, with circular flues behind the furnaces and horizontal iron tubes returned above the furnaces. Each boiler contains 79 iron tubes 2½ inches outside diameter and 9 feet 10 inches long. The boilers are placed side by side, with one smoke chimney in common.

Length of each boiler,	14 feet.
Breadth "	7 "
Height "	9 " 6 inches.
Area of the total heating surface in the two boilers,	1627 square feet.
" " grate "	48 1-6 "
Aggregate cross area of the lower flues in the two boilers,	6·812 "
Aggregate cross area of the tubes in the two boilers,	4·828 "
Cross area of the smoke chimney,	5·242 "
Height of the smoke chimney above the grates,	42 feet.
Capacity of steam room in the two boilers,	280 cubic feet.
Weight of sea water contained in the two boilers,	25·700 pounds.

Proportions.—

Proportion of heating to grate surface,	33·778 to 1·000.
Proportion of grate surface to aggregate cross area of lower flues,	7·071 "
Proportion of grate surface to aggregate cross area of tubes,	9·976 "
" " to cross area of smoke chimney,	9·189 "
Cubic feet of steam room per cubic foot of steam used per stroke of piston,	25·31

The natural draft of these boilers was very poor, as might be predi-

cated on their small calorimeter, about $\frac{1}{10}$th the grate surface, moderate height of smoke chimney, and large proportion of heating to grate surface, with the principal part of the heating surface in small tubes of very thin metal, and therefore very efficient in transmitting the heat. To compensate this deficiency of draft, and increase the power of the boilers, a fan blast was put into the smoke chimney to urge the fires to any required degree. During the whole steaming recorded in the logs, this fan blast was constantly and strongly driven, the steam following as soon as it was stopped, and during the latter part of the steaming, when the boiler had become considerably incrusted with scale and foul, even the most violent driving of the fan would not keep up steam during the operations of *blowing off* and cleaning the fires, the engines frequently stopping for want of steam on those occasions.

The evaporation by the boilers is calculated for a cylinder pressure 3 pounds less than the boiler pressure, and includes the loss of *blowing off* to maintain the sea water in the boilers at twice the natural concentration, and the loss betweeen the cut-off and steam slide valves and between the latter and pistons, but does not include the evaporation that furnished the small engine for the fan blast with steam. The total heat of steam is taken from Regnault's data.

The boilers were continually giving out by the corrosion of the tubes, which were so honeycombed over the whole of their thin surface and reduced in thickness, that the scale could not be knocked off without destroying them.

Remarks on the Logs.—The condition of the water is not stated in the logs, but as the wind was principally a light or moderate breeze, it is probable there was but a slight swell on or a moderate sea. The number of "consecutive hours" was taken for such lengths of time as the direction of the wind, steam pressure, double strokes of engine, pistons, &c., remained nearly constant, the extremes differing but a few per centums. The speed of the vessel was taken by the *chip log*, and as the top of the screw was but 16 inches below the surface of the water, its very great slip must have driven a considerable current aft, which affecting the log would cause its indications to be much too high; the true speed of the vessel must have been considerably less than what was logged. It must further be borne in mind that the force of the wind or kind of wind as recorded in the log, was judged of by the sensations of the observer on the deck of the vessel, and that what is logged as a gentle breeze ahead when under steam alone, is as really a calm, while what is recorded as a light breeze aft was in fact a moderate wind aft, and so on throughout. Inaccuracy in these particulars was unavoidable, but the log of the *Massachusetts* is in these respects as correct as the logs of other vessels, and the comparison is therefore not much affected. The amount of fuel consumed, though obviously inaccurately given in many cases, is what was actually put, or thought to have been put, in the furnaces during the hours recorded, and as the steaming was always commenced before and continued after those "consecutive hours," there are no corrections to be made for the heat expended in "getting up steam," or for burning down the fires before stopping.

With a view to compare the performances of the vessel under different

conditions at a glance, the following summary of the logs have been prepared; the mean draft of water did not vary materially, nor did the force of the wind or state of the sea.

Summary of the Results from the Steam Log.

	Under steam alone.	Under Steam Assisted by Sail.			
	Light breeze ahead.	Light breeze forward the beam	Light breeze abeam.	Light breeze abaft the beam.	Mean of the performance under steam assisted by sail.
OBSERVED.					
Total number of hours,	419	259	189	112	560
Speed of the vessel per hour in knots of 6082¾ ft.,	4·320	4·511	5·516	6·157	5·179
Steam pressure in boilers in pounds per square inch above atmosphere,	25	24	24	25	24
Part of stroke of piston, steam cut off at from	½	½	½	½	½
Proportion of throttle open,	Wide.	Wide.	Wide.	Wide.	Wide.
Double strokes of pistons made per minute,	37·55	35·94	38·76	40·84	37·87
Back pressure in condenser, in lbs. per sq. in.,	2	2	2	2	2
Pounds of Penna. anthracite burned per hour,	621	679	680	701	684
Consumption of anthracite in tons of 2240 lbs. per 24 hours,	6·654	7·275	7·286	7·511	7.329
Centre of the screw below the surface of the water in inches,	73	73	73	73	73
CALCULATED.					
Steam pressure in cylinders before cutting off, in pounds per square inch above atmosphere,	22	21	21	22	21
Mean effective pressure on pistons throughout stroke in pounds per square inch,	27·93	27·06	27·06	27·93	27·06
Horses power developed by the engines,	199·27	173·60	187·22	216·73	182.92
Slip of the screw in per centums of its speed,	41·68	36·38	27·86	23·58	30·68
Pounds of anthracite burned per hour per square foot of grate surface,	12·893	14·097	14·117	14·554	14·201
Pounds of anthracite burned per hour per square foot of heating surface,	0·382	0·417	0·418	0·431	0·420
Cubic feet of steam of atmospheric pressure furnished per minute, from sea water of twice the natural concentration, with temperature of feed water 100° F., including loss by blowing off to maintain twice the natural concentration, and loss of steam in the cylinders, nozzles, clearance, &c., but exclusive of the steam used in driving the fan blast,	2227·34	—	—	—	2187·39
Pounds of steam evaporated per hour from one square foot of heating surface, under the above conditions,	3·020	—	—	—	2·966
Pounds of steam evaporated per hour by one pound of coal, under the above conditions,	7·912	—	—	—	7·054

An inspection of the foregoing summary shows the speed against a light breeze under steam alone to have been 4·320 knots per hour with a power of 199·27 horses; and under steam assisted by sail with a light breeze forward the beam 4.511 knots per hour with a power of 173·60

horses; with a power exerted of 199·27 horses, comparing the speeds as the cubes of the powers, this speed of 4·511 knots would become 4·723 knots; hence it appears that the application of sails with a gentle breeze forward the beam gave the vessel an increased speed of (4.723—4·320=) 0·403 knots, or 9.33 per centum more than before.

Now the slips of a propelling instrument measures inversely the relative resistance offered to it by the water it acts on and by the vessel propelled. In the first of the above cases, the slip of the screw was 41·68 per centum, leaving the resistance of the vessel to be expressed by (100·00 —41·68=) 58·32 per centum. In the last of the above cases, the slip of the screw was 36·38 per centum, leaving the resistance of the vessel to be expressed by (100·00—36·38=) 63·62 per cent.; and 63·62—58·32= 5·3 per centum, which expresses the decreased resistance of the hull to the screw resulting from the application of sails, and 5·3 is 9·09 per centum of 58·32, or nearly corresponding to the 9·33 per centum of increased speed as given in the preceding paragraph.

With a light breeze abeam and sail set, the engines exerting a power of 187·22 horses, the vessel made 5·516 knots per hour; with 199·27 horses power, this speed would become 5·631 knots; hence it appears that the application of sails with a gentle breeze abeam increased the speed (5·631—4·320=) 1·311 knots per hour, or 30·60 per centum more than before. Under steam alone the slip of the screw was 41·68 per cent., leaving the resistance of the vessel to be expressed by (100·00—41·68=) 58·32 per centum. Under sail, with a gentle breeze abeam, the slip of the screw was 27·86 per centum, leaving the resistance of the vessel to be expressed by (100·00—27·86=) 72·14 per centum, and 72·14—58·32 =13·82 per centum, which expresses the decreased resistance of the hull on the screw by the application of sails, and 13·82 is 23·7 per cent. of 58·32; to have agreed precisely with the preceding determination, it should have been 30·6 per centum.

With a light breeze abaft the beam and sail set, the vessel made 6·157 knots per hour, the engines exerting a power of 216·73 horses. With a power of 199·27 horses, this speed would become 5·987 knots per hour. The speed without sails with a power of 199·27 horses being 4·320 knots per hour, there results an increase of (5·987—4·320=) 1·667 knots per hour, or 38·6 per centum more than before due to the sails. Under steam alone the slip of the screw, as before stated, was 41·68 per cent., leaving the resistance of the vessel to be expressed by (100·00—41·68=) 58.32 per centum. With sail set and a gentle breeze abaft the beam, the slip was 23·58 per centum, leaving the resistance of the vessel to be expressed by (100·00—23·58=) 76·42 per centum, and 76·42—58·32=18·10 per centum, the reduced resistance of the hull due to sails; and 18·10 is 31·0 per cent. of 58·32; to have agreed precisely with the previous determination, it should have been 38·6 per centum.

The discrepancies in the last two paragraphs between the determinations of the decreased resistances of the hull, from the different speeds of the vessel with equal power, and from the reduced slips of the screw, are owing to the incorrect assumption that the slips at the calculated speeds would be the same per centum as at the observed speeds, and that the resistance of the vessel is as the cubes of the speed. Instead of this, how-

ever, being the case, the slip would be greater when the calculated speed is greater than the observed speed, and less when the calculated speed is less than the observed speed; for the greater the power exerted upon the vessel by the engines, the less obviously will be the power exerted on it by the sails, and *vice versa;* also, the resistance of a vessel like the *Massachusetts* must increase in a higher ratio than the cubes of the speeds. Thus, in the first instance, where the comparison is made between the vessel under steam alone, and the same under sail in a gentle breeze forward the beam, the speeds 4·320 and 4·723 knots per hour, being so nearly alike as not to affect the calculations, whose results agree almost exactly, being 9·33 and 9·09 per cent. In the second instance, the difference between the speeds 4·320 and 5·631 knots per hour is considerable, and the determination of the decreased resistance of the hull by the powers and speeds is 30·6 per centum, and by the slips of the screw 23·7 per centum, a difference of 6·9 per centum, showing the resistance of the hull to increase in a higher ratio than the cubes of the speeds. The same result is found in the third case, where the steam is assisted by sail and gentle breeze abaft the beam; the difference between the speeds 4·320 and 5·987 knots per hour, is a slightly greater difference than in the second case, and there is also a slightly greater difference (7·6 per cent.) in the results of the calculations for the decreased resistance of the hull, made first by the powers and speeds, then by the slips of the screw, which results are 38·6 and 31·0 per cent.

We may therefore theoretically take the slips of the screw as inversely a measure of the resistance of the hull in the different conditions of wind, water, sail, &c., but practically there are modifications to this truth, owing to the fact that the action of the same screw in water changes with different slips, and that as the slip is increased the efficiency of the screw surface for propulsion is decreased, because the water set in motion by the anterior part of the screw blade, presents less resistance to the posterior part of the same blade, in proportion to the speed that has been given it, and this speed is in proportion to the slip.

The evaporation given by the boilers is a very high one, but there is a considerable discrepancy in the two cases, for which it is calculated; a portion of this, however, may be accounted for by the greater rapidity of combustion in the case giving the less evaporation, and by the greater waste attendant on the hard forcing of the fires to obtain this increased combustion; but the greater part is doubtless due to errors in the measurement.

To be Continued.

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*Blowing up of a Chimney at Warrington.**

The enormous chimney of the Chemical Works of the Messrs. Muspratt, at Warrington junction, was on Monday last blown up by gunpowder. Passengers by the London and North-Western Railway, who have had occasion to pass the junction, about twenty miles from Liverpool, have frequently been surprised at its enormous altitude and dimensions. It was 406 feet high; 46 feet diameter at the base; 17 feet diameter

* From the London Mechanics' Magazine, January, 1853.

at the summit; contained 3,500,000 bricks, 3500 tons in weight; and cost 7000*l.* erecting. There was only one chimney higher in the United Kingdom. The one connected with the chemical works of Mr. Tenent, near Glasgow, was 20 feet higher; but it was a much less noble-looking shaft, inasmuch as it was narrower at the base, and contained about two-thirds less bricks. The works have not been in operation for about eight months, owing to arrangements being made to remove them to another locality. There being, therefore, no further use for the chimney, it was blown up under the superintendance of Mr. Stephen Court, engineer and architect of the St. Helen's Canal and Railway Company. A number of holes were delved round the base; and fourteen charges of gunpowder were inserted. At half-past 2 o'clock the train was fired. Nine charges exploded without any apparent damage being done to the stablity of the shaft; but the report of the tenth had no sooner been heard than the chimney was rent from top to bottom, and the huge fabric fell, crumbling away gradually from base upwards. The whole of the column fell nearly within the circumference of its own base. A dense cloud of lime-dust hid the ruins for a few seconds; but when it cleared away, the 3,500,000 bricks were perceived in the shape of a huge mound. A large crowd of spectators had assembled to witness the downfall. No accident of any kind occurred.

For the Journal of the Franklin Institute.

The Caloric Ship Ericsson.

We are informed on good authority, that this vessel has had removed from her the large cylinders of 14 feet diameter, 6 feet stroke, as well as the supply cylinders of 11½ feet diameter, air receivers, regenerators, &c.; in fact, all of that part of the machinery peculiar to Captain Ericsson, and *patented* by him in the four quarters of the globe. There still remains on board, the shafts, wheels, and cranks, which being of the ordinary kind, may yet be of service. Having virtually abandoned every principle that he claimed, and which he advocated as late as the June number of *Appleton's Magazine*, the question arises, what will he do next? He has sustained himself as the perfector of a new motive power before the community, for the last eighteen months, by the strictest secresy as regards all practical results, and the exclusion from his ship of those capable of judging, and he now finds that those who have been termed by him smatterers have (perhaps through their ignorance) been true *prophets*. It will be a pleasure to those foundries which were unable to make 20 feet cylinders, to be informed that Capt. E., in the new engines now going on board, has concluded to use them of about 6 feet diameter. It will no doubt be a source of regret to the late Secretary of the Navy, who advised Congress to build two ships like the *Ericsson*, to know that the new engines will not admit of *those large double pistons* which, by the reports of Captains Sands and Ericsson, formed a *peculiar feature* of that ship, and insured such regularity of motion. In the new engines, now being put in, the large cylinders will have a diameter of about 6 feet, and the supply cylinders a diameter of about 3½ feet. The same air is to be used at a high pressure over and over again, and is alternately

heated and cooled as it passes through tubes immersed in fire (before it enters the large cylinders,) and water (after it leaves them.) It is presumed that the new machinery will be on board in time to go to Washington before the next Congress adjourns, as it is thought that from the large number of experimental ships that have fallen into the hands of the Navy department in times past, the Government could not do better than make another investment, much to the relief of those unfortunate individuals who have furnished the capital for the present *magnificent experiment.*

FULTON.

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*A New Iron and Coal Field.**

A detailed account of the discovery of an extensive coal-field, and of beds of iron-stone, in the county of Leitrim, Ireland, is given in the last number of the *Belfast News Letter*, and appears to indicate a new era of commercial and manufacturing prosperity for that country. It appears that about three miles from Drumkerin, six from Lough Allen, and nine miles south of Manorhamilton, there is a district called Crevelea, upon which operations were commenced last February by a Scotch company, for the purpose of making pig iron. Their mineral take extends to the side of Lough Allen; but their present openings are immediately in the district just named. A gentleman of great experience as a civil engineer, and a member of the British Association, now resident in Belfast, has just visited the scene of these operations, and from a brief memoir which he has made of what he observed, the following extract has been taken. He says:—"I found they had the coals cropping out in various places, consisting of two beds, near each other, each from 2½ to 3 feet in thickness. In proximity to these they have two strata of ironstone, the one in balls from the size of an orange to 18 inches in diameter, both most easily obtainable, and the former particularly of the best kind, being equal to any stone found in the three kingdoms, and both carbonates of iron, from which two tons of the calcined stone will make one ton of pig iron. The coal is a brilliant black, of the utmost value as to its cooking powers, as well as equal to the best coals of South Wales for evaporating steam, and singularly free from sulphur, the indication of which is only 0·5 per cent. I found a good road made, and all the outlay necessary for a blast furnace. An engine of more than 100 horse power, and the furnace, being heated, was to be able to charge in a few days; also large quantities of ore calcined, and coals ready, so soon as the furnace was sufficiently dry to use. From the way in which the coal and ironstone are obtainable, they can be brought to the furnace at about 3s. per ton; and, looking at the quality and the arrangements altogether, I have no hesitation in saying, that they will make iron as cheap, if not cheaper, than in either Scotland or England; and the quality of their pig iron will be second to none, since, with similar materials, this result has ever been insured. I expected a good deal from what I had heard before visiting the place, but it went beyond my expectations, and I returned satisfied that it only requires that district to be opened by railway communication in a very few years to make Leitrim the Staffordshire of Ireland. If such a field of mineral wealth were known

* From the London Mechanics' Magazine, January, 1853.

to exist in any part of England which had no such means of access, I am quite sure a very short time would elapse before it would be at once developed, and its riches made available. I give this opinion as an engineer long acquainted with mineral properties in England, and having no interest, personally, in any property in Leitrim."

The field of these operations is not very far distant from the Arigna Company's works, which have been, unfortunately, discontinued, in consequence of a combination among the workmen. The value of the Arigna ore is indisputable.

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*Trial Trips of the Impérieuse.**

At ten minutes before 2 o'clock on Monday afternoon, the *Impérieuse*, having previously got her steam up, steamed out of the basin by back turns of her screw, and on entering the river immediately started for her trial trip; the screw almost getting up to full speed at starting, and on proceeding down the river the engines worked remarkably well, making up to 68 revolutions per minute with the greatest ease, and causing her to leave the *Monkey* and *African* steam vessels, sent to attend her, far behind. Captain Watson, with all the officers, was on board, and Captain Hood, R. N., with Lieutenant Robertson, of the steam department afloat at Woolwich; Mr. Dinnen, inspector of steam-machinery afloat; Mr. Taplin, second assistant to the chief engineer at Woolwich Dockyard; Mr. John Penn, Mr. Mathew, and Mr. Hartree, of the firm of John Penn and son, the constructors of her engines of 360 horse power, on the "trunk" principle patented by that firm, and so successful in the *Arrogant* steam-frigate; and Mr. F. P. Smith, long connected with the introduction of the screw-propeller, into the naval service.

The *Impérieuse* went down the river in fine style, and ultimately left the *Monkey* and *African* far out of sight. On testing her speed at the measured mile, it was found to be upwards of 10½ knots per hour, the engines working most satisfactorily, without the slightest symptom of heating or anything going wrong. On casting anchor below Gravesend, all on board were much gratified at the manner in which she was brought up; as, notwithstanding her size, she appears as manageable as a small boat. A glance would at once afford evidence that she is a most powerful vessel, with ample room to mount and work with freedom guns of the largest calibre.

Her armament will consist of eight guns, each 9 feet in length and weighing 65 cwt., with an 8-inch bore, and twenty-two 32-pounders of 56 cwt., and 9 feet 6 inches long each. On the upper deck she will have one pivot gun 95 cwt., and 10 feet in length, for 68-pound shot, or 10-inch shell (already mounted); two 8-inch guns of 65 cwt. each, and eighteen 32-pounders of 45 cwt. each, and 8 feet 6 inches long each.

On the following day the *Impérieuse* had her steam up again shortly after 7 o'clock, and having heaved her anchor, started on a further trial trip between the Nore and Mouse Lights, in the deep water of that channel. She soon left the *Monkey* and *African* steam-vessels far behind, to the surprise of the crews of the numerous craft on the river. She arrived at the Nore at 35 minutes past 9, and finished her trial, running

* From the London Mechanics' Magazine, January, 1853.

the distance of 15 knots and 200 yards from the Nore Light to the Mouse Light and back, at 13 minutes past 11,—showing a speed of 8·927 knots against the tide, which ran very strong, and a speed of 12·420 with the tide, but against a double reef topsail breeze. The average of the run out and back to the Nore was consequently 10·673 knots per hour; the number of strokes of the engines, as counted by a machine in operation during the whole trial, was 67·7 per minute, and an equal number of revolutions of the screw propeller, 16 ft. 6 inches in diameter, and having a pitch of 16 feet. The draft of water of the *Impérieuse* during the trial was 16 feet forward and 18 feet 3 inches aft.

After the trial, the *Impérieuse* was steered for the Medway, and, having taken on board a pilot sent out by the Admiral from the port of Sheerness, she proceeded up that river, and arrived under the sheer hulk at Chatham at 5 minutes past 1 o'clock, P. M., where one of her masts and her bow-sprit where suspended in mid-air ready to be put on board. It is worthy of remark, as unexampled in any previous trials of engines for the first time, that there was not, from the moment the *Impérieuse* left Woolwich until she arrived at Chatham, an engineer's stoppage for one second to adjust any of the screws or other parts of the engines. Everything worked so satisfactorily that the few adjustments required were performed with the greatest ease while at full speed. The only times the engines had to be eased was when the numerous vessels in the river could not get out of her way.

Translated for the Journal of the Franklin Institute.

A New Modeling Clay.

M. Barreswill has prepared for the use of sculptors a modeling clay which does not dry, but remains constantly moist. His process consists in moistening the clay not only with water, but with a concentrated solution of glycerine, a liquid substance which does not dry.—*Cosmos, 20th Feb.*, 1853, *p.* 296.

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*Use of Cast Iron in Boilers.**

Cast iron has been used in France for some time to form the ends of the generators or "bouilleurs" of boilers, as they project beyond the brick setting, and are not exposed to the direct heat of the fire. The use of cast iron for this purpose is now, however, expressly forbidden by a recent order issued from the office of the Minister of Public Works. All boilers in France must be tested to three times the pressure they are intended to bear, and the operation is to be repeated annually. Cylinders of steam engines and steam drying cylinders are tested in a similar manner. It says much for the inspection practised in France, that boiler explosions are of extremely rare occurrence.

Brass Tube-making Machinery.†

A very ingenious machine for making brass tubes without seam, the invention of M. Degrand, has been recently established in France, and

* From the London Artizan, May, 1853. † From the London Mining Journal, No. 920.

promises very excellent results. The tubes are cast in brass, (say) 20 inches long, and of a great thickness. These are then put on steel mandrils, the diameter of which answers to the interior diameter of the finished tube. The tubes on the mandrils are then placed in the machine, and passed between fluted rollers under a considerable pressure. A reciprocating motion is given to the tube on which the mandrils are fixed, and, at the end of each stroke, the tubes are slightly turned round, to expose a fresh surface to the action of rollers. A continuation of this process swages out the short thick tube to a long thin one, of the desired dimensions. A machine under the same patent, has been set to work in England; and having been constructed after the one above mentioned, is still more simple and effectual. Under the ordinary system of making brass tubes, the brass is cut into sheets of the proper size, the alternate edges bevelled off in a planing machine, and the plate is then bent on a mandril with a hammer, and brazed, the bevelled edges forming the joint. The rough ends are then cut off in a lathe, and the tube cleaned with acid to finish it.—*Artizan.*

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, June 16, 1853.

Samuel V. Merrick, President, in the chair.

John F. Frazer, Treasurer.

John E. Addicks, Recording Secretary, pro tem.

The minutes of the last meeting were read and approved.

Letters were read from the Statistical Society, and the Institute of Actuaries, London; Charles F. Stansbury, Esq., Washington City, D. C.; Trustees of the City Library of New Bedford, Mass., and the Maryland Institute, Baltimore, Maryland.

Donations to the Library were received from Her Majesty's Commissioners for the Exhibition of the Works of Industry of all Nations (through C. F. Stansbury, Esq.;) The Society of Arts and the Institutions in Union, and John Weale, Esq., London; J. R. Snyder, Chairman of the Committee on the Geology of the State of California; Major J. J. Stevens, U. S. Coast Survey, Washington City, D. C.; The Long Island Railroad Co., New York; Trustees New Bedford City Library, Mass., and A. Hart, Prof. J. F. Frazer, and Edward Miller, Jr., Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of May.

The Board of Managers and Standing Committees reported their minutes.

The Board of Managers reported that Solomon W. Roberts, Esq., had, owing to his continued absence from the City on professional services, at the last meeting resigned his office as Corresponding Secretary of the Institute, and that they had unanimously elected Professor John C. Cresson to fill the vacancy.

The Board further reported that they had elected W. J. Marshall, Esq., Secretary of the Institute of Mechanical Engineers, Birmingham, England, a corresponding member of the Franklin Institute.

New candidates for membership in the Institute (3) were proposed, and the candidates (3) proposed at the last meeting were duly elected.

Mr. Fairman Rogers exhibited a level staff somewhat similar to one described in vol. XIX. of the *Journal*, p. 78. It is intended to dispense with the ordinary sliding target, and to remedy some of the inconveniences attending the use of the ordinary "Gravatt staff." The divisions in tenths and hundredths of a foot are not placed over each other, but diagonally across the face of the rod, forming a species of diagonal scale. The first five-hundredths in every tenth are marked by diamonds ·04 long, and the remaining five-tenths by dots. The feet are marked by red Roman numerals. This rod can be read 400 feet with a good 14 inch level, and appears to be quite as accurate as any other form. Its principal convenience consists in the fact that the leveller need not depend upon the rodman's reading, as he reads the graduations himself. It is decidedly the best form of staff without a target yet presented, yet the old target rod will probably be found, on the whole, more convenient, from its greater distinctness at long distances and in thick woods.

Mr. Jason M. Mahan exhibited an improved machine for planing off the backs of stereotype plates.

Dr. L. V. Newton made some remarks on his galvanized type, stating that experience had confirmed the favorable estimate in which it was held at the time he had previously presented it to the notice of the Institute, in March 20th, 1851, (see *Journal Institute*, Vol. XXI, 3d Series, p. 281.)

Dr. Alfred Kennedy exhibited a small surgical instrument for cauterizing. It consisted of two brass wires imbedded in a varnished cocoa wood case, and connected at the lesser extremity by a small platinum wire, rather finer than bell wire, bent in the form of the letter *y*. The bottom of the *y* was the cauterizing portion, and when required for use was heated by a current of galvanism from a battery, the conducting wires of which were attached to the instrument by thumb screws in the usual way. Dr. Kennedy had seen this cautery used in the service of M. Nelaton, at Paris, in August, 1851, and from a drawing taken at the time, Mr. L. C. Francis, philosophical instrument maker, of this city, had made that now exhibited, which was about the size of one's finger.

The heating effect of a current of galvanism through a fine wire of platinum had been applied in terrestrial and in sub-marine blasting. Dr. Hare had also ingeniously employed it in his eudiometer. This was one of its applications to surgery, and nothing could be simpler than its employment. The projecting wire was brought close to the part to be cauterized, an assistant at a signal given made the connexion with the battery, the platinum immediately became incandescent, the part was cauterized; at another signal the connexion was broken, and the instrument withdrawn cold.

In deep seated ulcers, in the posterior portion of the mouth, for example, the galvanic cautery possessed unequalled advantages. Unlike the actual cautery heated by flame, it excites no alarm in the patient, and

may even be used without his knowing what burns him. In large serous tumours, as in "white swelling" of the knee, the instrument is inconvenient from the large battery required. In a case of that disease in which it was tried, three half gallon Bunsen batteries failed to heat sufficiently to prevent the chilling of the wire as it was passed over the extended surface of the enormous watery swelling. For the smaller operations, the instrument must be classed among the many valuable contributions of chemistry to surgery.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on Mr. Thomas Armitage's Lightning Rod.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination, "a Lightning Rod," invented by Mr. Thomas Armitage, of Philadelphia, Pennsylvania—REPORT:

The lightning rod of Mr. Armitage differs from that ordinarily in use, by the substitution of a pointed magnet for the purpose of discharging the electricity from the clouds, in the use of a number of points for a peculiar purpose, and in so adjusting the magnet with its appendages that it may always be directed towards the point from which the storm is proceeding. Its construction is as follows:

The usual metal rod is extended from the ground to the top of the building to be protected, where it terminates in a number of iron points, which are painted for the purpose of preventing rusting. A few feet below this termination, a cross piece of iron works freely by means of a collar upon the upright rod, and carries at one end the magnet surrounded by points, while at its other extremity it bears ornamental figures of sheet iron, exposing sufficient surface to cause it to operate as a weather-cock, thus keeping the magnet always turned to the quarter from which the wind is blowing.

The steel, before being magnetized, is made to undergo a tedious process, the nature of which was not fully explained to the Committee, with the object of preventing it from rusting; it is then magnetized by subjecting it to a galvanic current. In the specimens submitted to the Committee, the magnetism communicated was very feeble, so much so as to lead Mr. Armitage to the belief that it was of a peculiar nature, having an attraction for iron, but not for steel, and presenting but one pole, and that of a different nature from either of those of ordinary magnets. The Committee of course demonstrated to him the errors in these views.

The supposition that this lightning rod is more efficient than the ordinary one, rests on the belief that a magnet exerts a greater attraction for electricity than a piece of platina, or other metal. As Mr. Armitage stated that experiments made by himself, in conjunction with another gentleman, had shown this to be the fact, the Committee felt of course bound to endeavor to confirm or confute this opinion by direct observation; and a course of experiments was in consequence instituted, in which the distance was determined at which the spark from the prime-conductor of an electrical machine could be taken by the same piece of iron, at one time un-

magnetized, and at another highly magnetized by the influence of the galvanic coil. This distance was found to be the same. The distance at which a point would prevent the accumulation of electricity in the conductor (as indicated by a quadrant electrometer placed upon it) was then tried, and found to be the same, whether the point was magnetic or not. They therefore believe that the opinion of Mr. Armitage, that a magnetic point will give greater security from the effects of lightning than an ordinary one, is fallacious.

Mr. Armitage has surrounded his magnet with a brush of iron points, and terminated the vertical point of his rod with a similar brush, believing that through them the electricity which enters by the magnet will be again dissipated. It is scarcely necessary for the Committee to advert to the error of this belief. The brush, which is undoubtedly the most effective termination of a lightning rod, loses in his rod very much of its efficiency by being thickly covered with a coating of paint, to preserve the points from rusting.

The idea of presenting the point always towards the storm is in itself excellent, but it is accomplished in this rod only by breaking the perfect metallic connexion which ought to exist between all its parts; which break might perhaps lead to accident, and must undoubtedly diminish the inductive efficiency of the point, when by the accumulation of rust at the collar, a bad conductor of electricity is interposed between the magnet and the ground. The same advantage is fully gained by terminating the ordinary lightning rod by a ring or brush of points of platina wire, pointing in all directions.

In conclusion, therefore, the Committee cannot approve of the method of constructing lightning rods proposed by Mr. Armitage:

First, Because they do not believe that the magnet is in the least more efficient in discharging the electricity of the thunder cloud, than an ordinary metallic point.

Second, The efficiency of the point is reduced by the want of perfect metallic connexion between it and the ground.

For these reasons, the Committee believe that the lightning rods thus constructed are decidedly inferior to those commonly used.

By order of the Committee,

Wm. Hamilton, *Actuary.*

Philadelphia, June 8, 1853.

BIBLIOGRAPHICAL NOTICES.

Elements of Mechanics: elucidating the Scientific Principles of the Practical Construction of Machines. By T. Baker, C. E. London: John Weale, 1852.

This is a little book which will be found very valuable to young mechanics and inventors, intended as it is to give them an account of the various contrivances which have been devised for the purpose of modifying motion so as to suit it to particular purposes. The mechanical principles announced at the beginning are by no means as clearly laid